Alfalfa in America

BY

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INTRODUCTION.

In March, 1886, the writer, a tall awkward young man fresh from the fields of Ohio, was traveling by rail through Utah. Near Provo he began to see snug farms with trees, meadows, orchards, granaries and haystacks. Some of these stacks had been cut in two with the hay knife, and he noticed with wonder the beautiful green color of the fresh cut surface. Calling the attention of the conductor to this phenomenon, so strange to him, he asked, "What sort of hay is in those stacks?" "Lucern," promptly replied the conductor. "And what makes it so green?" "It's green because that's the color of it," sagely replied the smiling conductor, as he pocketed a cash fare and moved on about his business. At that date lucern, or alfalfa, had not spread much east of the valleys of Utah; some was grown in Colorado, but it was a new thing there. The Utah farmers were many of them English and Danish, hence their choice of the old name lucern, while the Spanish term alfalfa had come in from Chili by way of California.

Late that night the writer reached Salt Lake City and early next morning he was up ready to explore. In his rambles about the quaint old city (more old-world than American at that time with its houses of adobe, its walled gardens and orchards, its rows of towering Lombardy poplars) he came across a

square devoted to the hay market. There stood awaiting purchasers dozens of loads of this curious green-looking hay. He went to a load of it and drew out a stem and chewed it to see what it tasted like. To his astonishment it tasted good, much as wheat tastes when chewed. It dissolved in his mouth and tasted as though it would nourish him. "The best country I have struck yet," remarked the boy to himself. "If ever I get hard up here I can at least go to a haystack and eat lucern hay. I won't starve." Curiously enough it later came to his knowledge that this first impression was true, that alfalfa hay has really in it nearly the same amount of nutrition, pound for pound, as has oats, and from oatmeal have come mighty good men.

Next the boy lived for a time in Salt Lake City and cared for his uncle's cow. She was a fine motherly cow, very wide where width did the most good, low down and gentle, with a big mouth and an appetite to match it. He fed her on alfalfa hay without grain. What milk she gave! That cow must have been a freak, for she gave some 5 or 6 gallons a day of rich creamy milk with no other food than alfalfa hay and hydrant water. Steadily as he milked the cow the respect of the boy for alfalfa hay grew.

Next the boy went down into the deep mountain canyons along Green River and worked there on a cattle ranch. It was a great ranch in dimension, full 40 miles in extreme length, extending from the horrid cliffs along Price River to the cool heights

of the Big Mesa, sloping down to the Nine Mile. Through this ranch ran a little creek called Range Creek. The soil was sandy and gravelly along the creek, not very fertile. The climate was intensely hot; often the thermometer would climb to 110° and stay there day after day. Cattle and horses were kept on the ranch, some 2,000 cattle at times. In the narrow sandy valley little ditches were made to lead the water from the bubbling creek, idle for ages though once Cliff Dwellers had farmed along its banks and grown corn, which they had stored in adobe and stone treasure houses high up under the cliffs. Now little fields were cleared from their encumbering sagebrush and grease wood, the water turned on, and they were planted to corn and alfalfa. It was called lucern then; later the name alfalfa overpowered and became almost universal. At first the alfalfa did not thrive along Range Creek. It made a small feeble growth, but it stuck. In one field especially, down close to the headquarters cabin, alfalfa grew the first year no more than about 6 inches high. The boy, who already had charge of the farm and general charge of all the ranch, was disgusted with it and wished to plow it up and try something else. The soil there was sandy, gravelly, open and rather coarse. An old-timer happening in at the right time counseled against plowing it. "Let it be; you may have good alfalfa there another year," he said. This advice was heeded; the next year the alfalfa there grew so high that when the burros would walk out into it only

their heads would be visible. It produced four crops of hay and easily 8 tons to the acre. Water for irrigation was very abundant at that time in Range Valley. It was the custom to flood the land over just before cutting off the hay and once afterward.

At that time no one knew anything about soil inoculation and the behavior of alfalfa was a profound mystery. It now occurs to the writer to explain the curious behavior of the alfalfa in this manner: up the canyon a mile or two was an established alfalfa field, not a good stand, but thrifty. When this field was irrigated the surplus water flowed on down to the lower field and went over that. It seems clear now that in this manner the bacteria were introduced from the established field to the new one. As long as the writer had connection with this ranch, some twelve years, this field continued to produce heavy crops of alfalfa, though not so wonderfully rank as the earlier growths. Doubtless the excessive irrigation leached away some fertility, and the continual removal of hay without returning any manure or fertilizer told, even on that very deep and pervious soil. However, the last crops that the writer remembers growing on this field could hardly have been less than 5 tons to the acre.

It used to be a great joy to grow alfalfa on this old ranch. Before the alfalfa came there was nothing in the valley to relieve the monotony of brown, drouth-stricken nature. The alfalfa fields were vividly green squares and patches, relieving the monotony of brown sage brush and bare earth. The

advent of the alfalfa changed the animal life too of the canyon. Before alfalfa came there used to be little animal life save the chipmunks and lizards; all had fled that could flee to the green mountain tops. After alfalfa deer came to stay down in the meadows all summer long; some of them had their little fawns down there. The boy foreman used to see the old does standing deep in alfalfa nibbling daintily very early in the morning as he went up to change the water. He would not shoot them; they were his companions. Humming birds too came in great numbers to sip the sweet nectar of alfalfa bloom. They would sit in quaint rows along the wire fence, peering curiously at the boy as he passed by smiling, shovel on his shoulder. Bees he had none, else there would have been great stores of honey made there.

It was joy to grow the alfalfa, because the growing of it was so very easy. The method of sowing was very simple. The fields were first made fairly level. There was a strong slope so that it was easy to get water to any part of them. Then furrows were made with a common turning plow run shallow, or else with a furrow marker that made a number of shallower furrows parallel with each other. Then the alfalfa seed was sown, sometimes brushed in with a brush drag, and then a tiny stream of water turned in each furrow and kept running there for days and days, since under that burning sun one could not count on sandy land holding moisture at the surface very long. Sometimes the alfalfa was sown in March, oftener in April. It did not make

much hay the first season, hardly any in fact; the second year was when it began to hump itself. By the second year all furrows were pretty well leveled down or washed away; then the land was irrigated by flooding. Large ditches were placed across the heads of the fields, with lesser ones transversely lower down. The head ditches were provided with dams hastily thrown up across them from the sand of the ditch bottom. Then as big a head as could be mustered was turned in and all of it turned out in one place. The irrigator got out with his shovel, often in bare feet, and helped it flow this way and that, spreading it so that it covered that part of the field with an even-flowing sheet of water a few inches deep. When it had flowed a few hours the dam was broken, the stream carried further along to another turnout. By this simple plan of irrigation the writer unaided one summer watered about 90 acres of land. That was a happy summer. He had a big white burro, "Old Nig," which he kept saddled most of the time. Nig knew the work about as well as the boy knew it, and he would gallop merrily up the road to the top of the field in the morning, about two miles from the cabin, stand patiently under a cottonwood tree till the work was done there; then with his master on deck gallop cheerily down to the next field, and so on till all the water had been given attention. There is a great fascination in working with water and the writer yet thinks irrigation farming one of the finest schemes in the world.

The making of the hay was hard work, but not

accompanied with worry, because usually no rain fell between April and September. We used to mow down the alfalfa and rake it while quite green and as soon as possible pile it up in big cocks and leave it there to dry out a while. In that hot sun and baking air the moisture disappeared very rapidly indeed, so that by the time we could get to hauling, the hay would be dry enough, and thus it retained perfectly its color, leaves and delicious aroma. Very joyous times we had at this haying, a lot of harum-scarum cowboys and ranch hands, strong as wild colts and rejoicing to see which of us could lift the largest forkful of hay.

At first we simply hauled the hay on wagons and stacked it by hand. Later an ingenious Mormon boy showed us how to rig a pole stacker, and then we let the horse do the pitching. We accumulated great ricks of hay, hundreds of tons, against possible severe winters.

Meanwhile we were feeding alfalfa to our saddle and work horses, to poor cows and calves that would have died before green grass came had they not had this help, and occasionally fattening a bunch of beef steers on it for the spring market, when fat beef brings a premium in Denver and Salt Lake City. We had no grain at all and fed only alfalfa hay, making with it very good beef indeed, though doubtless we would have made much fatter cattle had we had corn to feed along with it.

We had a few old sows on the ranch and must make provision for feeding them and their pigs.

They were astonishingly prolific sows and gave us great litters of healthy pigs, so many sometimes that we did not know what to do with them. The sows were kept penned up nearly the year through and during summer we simply cut alfalfa with a scythe and threw it over to them. This kept them in fine thrifty condition and their pigs grew but kept rather lanky on the diet. When fall came we would fatten them off with pumpkins and squashes and alfalfa. In winter time we would vary the diet by giving them dry alfalfa hay and alfalfa leaves. They throve well and it was at first very amusing to see hogs eat alfalfa hay, putting their feet on it to hold it down while they tore it apart with their teeth and chewed it as best they could. It was wonderful to us also to see what fine full udders our milk cows had. Old-fashioned milking Shorthorns they were, of the type that the fathers had. The Mormon settlers had brought with them their best family cows when they came across the range, and we had some of their descendants. We fed these cows only alfalfa hay in winter, and mostly soiled them on green alfalfa in summer, and what splendid foaming pails we carried down from the corral! We half lived on milk and cream those days, being too busy to make butter. Sometimes we had trouble from alfalfa bloat. That came in the fall, after we had turned the cows on the meadows and they grazed the alfalfa that had come up since the last mowing and gotten badly frosted. We used to have strenuous times with these old cows, tying sticks in

their mouths like bridle bits, making them stand with their heads up a steep bank and putting cakes of ice on their distended sides. We never had one die, but learned then that frosted alfalfa is never a safe feed for a cow.

Over on the Castle Valley desert were Mormon settlements, Castle Dale, Ferron, Price and other villages. They were on adobe soil mostly, a sad sort of alkaline clay, full enough of minerals but lacking in humus and life-giving properties. The first attempts of these settlers to grow grain were mostly unsuccessful; it would not thrive, and the people were incredibly poor. Little by little they got alfalfa to growing on this alkaline soil and then with cows and pigs and poultry they managed to live quite well. Finally one of them let the water run over his alfalfa in the winter so that it froze into solid ice over his field. This is sure death to alfalfa, unless there is air under the ice, and in the spring he had lost his meadow; nearly every plant of alfalfa was dead. He grieved over this, but set to work to see what he could get from the land and planted a part of it to spring wheat, though it had previously refused to grow wheat, and a part to potatoes, also a very uncertain crop at that time in Castle Valley. The result was a crop of wheat that made 60 bushels to the acre, a marvel to the whole valley. The potatoes made some unheard of yield, about 900 bushels to the acre, I think, and the fortunes of Castle Valley with its sun and brilliant skies and wildly desolate plains and crags was assured.

These valleys were fertile, they would yield food for man and beast, and alfalfa was the magic sesame that made open the door to the riches of the valley.

All this time the writer was becoming more and more enthusiastic over the wonderful value of the alfalfa plant. Back in Ohio was the old home farm where he had spent his boyhood. It was a little farm of less than 200 acres, charmingly diversified by little hills, rich flat meadow lands, wet and half wild, in which grew wild lilies and pink fragrant spireas. There was woodland and pasture, a running stream, the Darby creek, with swimming holes in it, a big pond where he had sailed his tiny ships not so very many years before, a corn field, usually of about 15 acres, meadows in irregular patches, and an old apple orchard that bore famously of big red apples. On that farm too was an old man once tall but now bent and gray, weatherbeaten, seamed and furrowed from exposure, with a kindly serious face and a twinkling blue eye. That was the father. And a mother, small and agile and energetic, rather frail yet sunny and happy, ever singing at her work. That was mother. And two younger brothers did the work about the barns and went to school. These younger brothers, men now, are yet on Woodland Farm and are the writer's partners.

The writer had been a very close friend of his father, and together they had planned the work on Woodland Farm before he had gone west, and now the old man remembered his boy and knew of his interest in the old place, so he used to write now

and then long and careful letters telling of what he was doing, of the drains that he was laying, or the good corn that he grew. And the boy in his very first enthusiasm for the alfalfa plant sent home a package of seed by mail (that was in 1886) and asked the father to give it space and soil and care. And often in his daydreams he would ponder the question of returning some day to the old farm. He would dream idle dreams of what he might do there, how he might enrich it and plant it and maybe buy neighboring acres to add to it.

Somewhat more than two years rolled away and the boy took a vacation and went back to the old home, to see the home folks, and a sweetheart he had there. It is a very joyful and rather a wonderful thing to come home after having been exiled to a strange land. The deserts of Utah were like another world, so that when the boy came to Ohio it was as though he had come to a dream world, so beautiful, and so natural and so lovely it all seemed. How eagerly he explored his old haunts, one by one! What old memories were stirred into life as he saw the meadows, the woodland, the hill planted to corn and kept immaculately clean of weeds, the orchard, the garden; the dear old father, stooped and aged more than the boy remembered him, went right to his heart; the mother, silvery haired now; the sister and young brothers! The sweetheart was of course unspeakably marvelous and wonderful, and it all was as though the boy had been born again into a new world. Soon after his arrival, as he explored

with diligence, he asked the old man: "Father, where is my alfalfa? Did you plant that seed that I sent you?" "Why, yes, I planted it, but it did not amount to anything. This is no country for alfalfa. It may do for you in the West, but it is of no use here; but come and see it, what there is of it." Back of the garden the old man had spaded a square rod of good clay soil and sowed his seed. He led the way and pointed accusingly to the stunted little plants scattered thinly over the ground: "There, don't you see that this thing is no good for Ohio?"

The boy stood in amazement looking at it, so different from what he had fondly hoped it might be. His father turned away and left him, but still he stood studying the situation. Soon happened along a flock of his mother's fowls; they came to the alfalfa patch and began an eager search for leaves; one by one they plucked them off till nearly every plant was stripped bare, then walked away. "Aha!" cried the boy; "I see a light now," and he went to the well and pumped a tub full of water, which he carried and emptied carefully down by the strongest root that he could find. It was early August and the land was dry. To keep away the chickens he took an old barrel, knocked the heads out of it and put it over his alfalfa plant. In a little more than three weeks he was ready to go back to his work on the ranch and he went to say good bye to his alfalfa patch. To his delight the stalk of alfalfa had thrived for its wetting and its protection and had grown out through the top of the barrel! Joyfully

the boy called his father, "Come here; see what my alfalfa has done!" And the sire, amazed and bewildered at first, stood there scratching his old gray head and smiling an amused, puzzled smile. Finally he turned and said: "Son, do you suppose that I want to grow a crop that won't grow till you put a barrel over it?" The lad laughed and said no more, but went back to his mountains and the alfalfa fields, remembering the one stalk of alfalfa that had succeeded and saying, "I know that alfalfa can be grown in Ohio. If one stalk will grow as that one grew, why can't a man grow a thousand? If he can grow a thousand, why can't he grow a million, why can't he cover his farm with alfalfa?"

The ranch was not just the same to the boy when he came back to it, not just the same because he had ever before him the image of the sweetheart left behind. Yet it was a happy place, and he went tumultuously into the work again, strong as a young giant, eager to do, finding no day long enough for him. Now was time of happy dreams, and after a time the dreams began to materialize as he mixed mud and made "adobes," or "dobies," as the boys called them, and hauled down logs from far up the canyon, for She was coming and a house must be made ready for her.

There were wonderful letters coming, too, and often the boy would be seen on Sundays sitting far up on the rocky hillside, away from the confusion and talk of the cowboys, reading the last letter that She had written, or writing one in reply to it. The work

of the ranch was much the same as it had been save that the ricks of alfalfa grew larger and larger each year and the problem of making and using the hay grew to be portentous. The mountains remained the same always, and the boy loved them deeply and climbed them eagerly, going up where never white man had been before, just to gaze off afar to other snowy ranges, and across sunny yellow valleys in the desert, beautiful from afar. All the cowboys loved him and worked faithfully for him; every one worked as hard as he could and the cattle waxed fat on a thousand hills.

In November it was that the letter came, the letter written in that familiar crabbed yet plain handwriting that the father used. Nearly always the father's letters gave the boy much pleasure. He opened this one expecting it to be like the others that had come, but it was a shock to find in it a totally different note. It read like this: "My boy, I wish you to come home. Times are hard back here; hired men are no good any more. I am getting old and infirm. I need you very much. Come home and help me with the farm. I do not see how I can get along without you longer."

The letter gave the boy a rude shock. All at once he realized how he loved the wild ranch with its freedom, its responsibility, its opportunities for doing things. He loved every hill and every mesa and every canyon. Half of the canyons he had named, some of them he only had ridden through. He loved the sun and air, the yellow bunchgrass, the

solemn pines. He loved the horses that he rode and the great herd of cattle in his charge, and his comrades, rough as bears and loving as brothers. So he carried the letter in his pocket with a sad heart for a day or two, when little Billie Barnson, who was riding beside him, turned to him and said: "Joe, what in thunder is the matter with you? Has your girl gone back on you?" "No, Billie, that is not what is the matter," and in a few words he laid bare his heart; he ought to leave the mountains, perhaps forever, and he dreaded to go. "Why, Joe, I'm ashamed of you." "Ashamed, Billie? Why are you ashamed of me?" "Well, Joe, if I had had a father as good as yours has been [Billie had never known his father] and in his old age he asked me to come home and help him, I'd go." That decided it. "I think you are right, Billie. I'm going." "Well, I want to see you smile then." "All right, Billie, I'll go, and I'll smile too," replied the boy, and his heart grew light again as he began to turn his thoughts toward home once more, and the simple but satisfying joys of the homeland.

The homecoming occurred just before Christmas time of the year 1889. It was a very joyous homecoming. The kind and rejoiced old father, the old mother happy to see her son, and the things made dear by old association, all these conspired to make full the cup of joy; and beside near by lived the sweetheart. So the boy was very happy for some days. After that he began to explore again the old farm. It was a good farm, of 196 acres, mostly

meadow and pasture land, with a fine bit of woodland, and about 50 acres part of the time under the plow. It was farmed in the old-fashioned way—corn followed by wheat and wheat by clover and timothy. Hogs were kept and cattle; timothy hay was sold with wheat, pigs, fat steers, potatoes, parsnips, pears, grapes and a few minor items. The father was a careful man, economical to a degree, hard working and patient. He loved his land and cared for it as best he could, saving every scrap of manure and tilling the soil with diligence. He loved his animals and fed them well. His driving mare was almost too wide to get between the shafts; his cattle knew him and would stand to be rubbed and petted. It was through no lack of industry or intelligence that the father had not of late years made the farm pay; it was due mainly to his following an unprofitable system of farming.

When the boy came home there was an old lame negro man helping do the farm work, old "Uncle Sam" they called him, a faithful old soul but slow and feeble. In the feedlot were about eight steers, maybe twenty pigs were being fattened, in the crib probably 500 bushels of corn, in the mows maybe 50 tons of hay. The boy took it all in very rapidly and a great hunger for the old ranch came over him, a hunger and a longing for its wide free life and its endless range of activities. To add to his unrest a letter followed him, a letter from the manager. It read like this: "Come back, Joe, as soon as you can. Your place is awaiting you, and more wages if

you think best, and we will build the house for your sweetheart, and you shall be your own boss. Come back as soon as you have your visit out."

Small wonder then that the boy soon began seeking to frame some explanation or excuse to offer the father, some way to tell him that he could not stay to care for the little farm, with the great ranch calling him. And the father could read the boy's mind like an open book, so one morning after family prayers he said: "My boy, I wish to talk business with you. I suppose you did great things in the West. You probably had 2,000 cattle there, if you say you did. I don't know, as I never saw that many cattle together and never expect to; but I wish to show you that this old farm is not played out either. Now see here, here is what we have done this year." Then he took down from the shelf his old account book and read off the items, all duly set down in black and white, the wheat that he had sold, and the hay, the pigs and the potatoes and the cattle. And together they carefully footed it all up. It amounted altogether to a little less than $800. Eight hundred dollars! It came over the boy the good salary that he had forsaken in the West and all the bright hopes of that golden land and his heart went down like lead. "What," he said to himself, "have I given up all my bright prospects, all my plans and aspirations to come back and manage a farm that does not produce more than $800 a year? Why, with such an income as that, with taxes to be paid and repairs to be made and all expenses to be met,

I can not so much as keep old Uncle Sam. I must myself get out with the lantern before breakfast and feed and curry the horses and begin over again to do all that drudgery that I had only lately escaped." It was not a very worthy thought, but it added to his perplexity.

The old father waited anxiously for the boy's decision. Very gently he said: "My boy, when you were with me we made more money than this. The farm then was in better condition and times were not so hard. I am too old now to develop it as it should be developed and I am tired. My happiest memories are of the time when I was strong enough to be called a man, and you were my boy, helping me. Now I am tired of being the man; I wish you to be the man. Won't you be the man, let me be the boy and help you?" There was silence for a little time while many thoughts passed rapidly through the boy's mind, then he came to decision. "Yes, father, I'll stay. I'll take hold of the old farm and do what I can with it. I think we can make it profitable after a time, and you may help me."

"Good," the old man exclaimed. "Now you go ahead and do whatever you wish to do. I'll give you chance to do it, for I'll feed the cattle and the pigs. I can feed them better than any man you can hire, and you know it." "Of course you can," replied the boy. Then: "Father, let's go and take a walk." "All right; where shall we go?" "Oh, anywhere; just out to look at the farm again." Together they sallied out, the father happy as a child, the son glad

that it was settled, the uncertainty over, yet uneasy, feeling within him a rising tide of restlessness, an aching to get to work somewhere.

They did not walk very far. Just beyond the barn was a field of flat clay land, wet, mostly poor and unprofitable. All over the field rose little clay chimneys, the work of crayfish. The boy stopped here. "Father, may I drain this field?" "Yes; it ought to have been done years ago," was the reply full of hearty encouragement. The boy went to the village and came home with a ditching spade with a blade 18 inches long. He stretched a line where the first ditch was to be laid and began digging a long narrow ditch in which to lay tiles. How happy he was all at once! Those ranch muscles of his were in good training; mightily he dug. And as he began pushing his muscles against that soil he began to believe in it, to have faith in it. And after he got down in the ditch and had rubbed the mud on him well he forgot the old ranch. When at last the ditch was dug and the tiles laid and covered there was one strip of land dry, only a beginning, true, but it was a beginning. The boy stood there that afternoon as he finished covering the tile and leaned on his spade and dreamed, and talked aloud to the old field. "Old field," he said, "some day I will make you all dry. Some day, old field, I will make your soil rich. Some day I will cover you over with clover, and with corn, and with alfalfa too. Some day, old field, out of you shall sprout and grow a home, a home for that sweetheart of mine." And

he looked at his watch; it was past 5 o'clock, so he went home and shed off his muddy overalls and went across the fields to see the sweetheart, happier than any king.

Spring came in all its maze of bewildering hope and promise and beauty, as it comes in central Ohio, and the boy was supremely happy. There was just the joy of seeing God's miracles all around him, the bursting buds, the unfolding leaves, the blossoms on every twig, the tender grass hiding the dull, ugly earth, the dewdrops sparkling in the morning light and all the little birds singing cheerily their songs of gratitude and joy. There seemed something prophetic in it all, and something very wonderful, God's forgiveness, God's fulfillment of His gracious promises. In a dim way the boy understood and believed, and realized his own duty in the matter and bent eagerly to the task, seeking in a way to make himself partner with the Almighty to cover over the few acres entrusted to his charge with growing things, with bloom and with beauty.

Yes, it was the joyous seedtime when all one's hopes spring up anew and he has prophetic insight into what may be and what should be, not only of the good green earth, but of one's own soul as well. Every morning bright and early the boy was astir in the fields, with a faithful colored man, Frank, to help him. He had brought with him from Utah two bags of alfalfa seed and this he wished to sow. But the father was much alarmed. "No, my boy, we cannot afford to sow so much as that at one time. It

has not been tried yet. You may have that potato patch down by the old orchard; that is good soil. Begin there and if that succeeds we will sow more later on." The potato patch had in it one-third of an acre. That was quite a coming down from his expectations, but he acquiesced and sowed the little field. Fortunately it was a good place to begin. The land was a strong clay loam, fairly well drained. It was full of carbonate of lime, for all through it were little pebbles of limestone. It was rich, for the cattle had stood there much when it was a part of the orchard. In some way or another it had become inoculated with alfalfa bacteria, perhaps because the father had grown sweet clover on the farm for years in odd corners and in his dooryard. So this alfalfa started out vigorously and grew well. The boy was delighted. He had a path well trodden where he had walked to see his first field. It settled in his mind the question of whether alfalfa would grow; he had no doubt whatever now that it would grow. Rapidly his mind went on ahead to the time when he would have 40, maybe 100 acres in alfalfa. The farm at that time had in it only about 50 or 60 acres of land that could be plowed. The rest was wet or poor or covered with trees.

That summer came another boy from the old ranch, Willis. He was a wiry, slender lad, just out of his high school, and had spent about a year at ranching, getting health and strength there preparatory to going further with his education. He did not then dream of becoming a farmer, yet he was

as enthusiastic as the older brother over the beauty and promise of the little alfalfa field. He took off his coat and helped with the farm work and enjoyed it hugely till September came, when he went away to school again. It happened that he never finished his education in school; the confinement of the schoolroom was too much for his health, so fortunately for the farm he came back a few years later to be a partner, and later to have almost entire management of the farm. Willis dreams dreams of his own and makes them come true, and he loyally carries out the plans of the writer. Woodland Farm owes its final development very largely to the energy and executive ability of this younger brother Willis. And there was another brother yet, a sturdy lad, Charles, growing up at home; he grew to be the largest and strongest of them all and mightily he bent his muscle to help with the work. Later he too spent years in the West, ranching with sheep and cattle, and harvesting alfalfa hay there. Then he also came home and found on Woodland Farm ample scope for all his energies. It is true, is it not, that any work is as big as the man who undertakes that work?

That first summer was uneventful save in the fact that the alfalfa grew so well on the trial patch. It was a year of drouth and the corn crop was nearly ruined, only about 500 bushels in all being harvested. The chief events were the long and delightful drives that the boy took with his sweetheart and the frequent walks he took to watch his alfalfa. When

fall came the sweetheart and the boy drove out one day along quiet byways and gathered a buggy load of wild flowers and vines and with these decorated the sweetheart's home, and that night they were married. Next day they went on a honeymoon journey, with the same old horse and buggy, out again into the country, driving slow beneath the old oaks that overarched the road, and more than ever the boy resolved that his life should not be a failure; that in some way he would strive mightily to be worthy of her, who had been an inspiration to him since she was a merry child of eleven, with sunny curls hanging down on her shoulders. And as soon as they were married he began digging for the foundations of a little cottage in the corner of the woodland, a cottage where she might be mistress. All winter whenever it was warm enough he worked on the cottage, so that it was done nearly altogether by the labor of his own hands saving that the sweetheart's father came to help now and then. In June they moved in. All was fresh and new and clean, the whole air was full of hope and life was very joyous then.

That spring they sowed another field to alfalfa, this time a little field of about 3 acres. And this field taught a much needed lesson. It began down by the creek where the land was low and wet, ran on up over a little hill where the land was dry and filled with limestone gravel, extended on back over some flat cold poor clay. And on only one acre of the three did the alfalfa thrive; that acre lay on

the rich dry hill, full of limestone pebbles. Down by the stream the alfalfa was weak, sickly, soon taken by the crowding grasses and weeds. Back on the flat wet poor clay it amounted to very little. On the dry rich soil full of carbonate of lime it thrived beautifully. So there the boy stood and pondered; the lesson was plain, though unwlecome. "It is evident that this farm is not ready for alfalfa," he said. "I'll make it ready. I'll drain the wet land. I'll enrich the poor land. I'll grow alfalfa; some day I'll have 40 acres of it, but not so soon as I thought I would." So then began the work of laying tile underdrains in earnest. The father had laid many in his day, but not nearly enough, judging by the new standard that alfalfa set up.

And that fall the kind old father died, died in a peaceful and happy sort of way, as almost anyone would be glad to die. He had been fairly well that summer, and had insisted in helping in the hay field, raking with the horse rake and cheerily, almost gleefully, showing the men that he was by no means worn out. One morning he arose early, as was his habit, and went out to work in his garden before the breakfast time, and there the boy had his last talk with the old man, and arranged with him about going to the fair soon to come off. After breakfast the father went to the barn and hitched his gentle mare Daisy to a spring wagon and got ready to go to the village on some errand, probably to take some vegetables to market. When the horse stopped at the front gate, coming from the barn, no one seemed

with her, and when the women of the house went out to see they found the old man lying in the wagon as though peacefully sleeping, with a half smile on his lips, dead. It was a fitting end. He had lived a strenuous life, he had been good, he had been kind; he had been builder not destroyer, and wherever his foot had been put down there rich grasses and clovers had sprung up.

The writer makes no pretense of being as good or careful a farmer as his father was. We try to follow in his footsteps, that is all, and we do things in a larger way than he in his old age cared to do them. Yes, the father was gone, and with him the safe counselor, and the boy all at once realized how much he had depended upon this counsel. He could do as he pleased now, but he was not glad of the chance. He would have been very glad indeed if he could have had the continued company of the old father.

He took account of stock. The farm was not paying; the crops that grew upon it when all sold could not possibly bring money enough to make it a business worth while. Much of the land was too poor to be profitable. The little alfalfa fields paid well, but they were but small spaces after all; the rest of the farm was mostly unfit for alfalfa. The farm needed enriching, needed further drainage. If ever it paid it must be made rich. How? Well, there was stable manure. The boy knew about that; the old father had been a most careful user of manure; he saved all that he could, but he fed his cattle out in the woods where the manure was largely wasted.

The boy reasoned: "Our practices are wrong. We sell off timothy hay and wheat, and thus load by load we sell away the fertility of the farm, and what we do feed is largely wasted, as we do not get the manure. Now if ever we build this farm up we must feed on the land the crops that we grow upon the land. And if we make any money in feeding animals we must feed younger animals than we have been feeding. We must feed some sort of babies. Now what shall it be?"

Then he thought of the lamb. "Why, here is the lamb," he said. "He is a baby, a gentle little fellow. One can put him in the barn, can feed him there in shelter. His manure will all be saved in good order and can go direct to the fields with no wastage, and from the feed given him one ought to make good gain and thus make money." He had already a little flock of ewes which were his pets and his darlings. To them he added now a little bunch of 200 feeding lambs, building a shed to hold them. As he had no money only what he borrowed, he bought the smallest and cheapest lambs that he could find. They were natives, fairly healthy, and weighed 55 lbs. when he put them in the sheds in November. He had carefully dipped them in a half barrel, and had himself as thoroughly dipped as the lambs, so they were free from ticks. All winter he fed them carefully, every feed with his own hands. Not knowing anything about feeding lambs, he had written to Prof. E. W. Stewart to get his advice as to how they ought to be fed, and he had told him how to

compound a ration with wheat bran, oilmeal, corn and mixed timothy and clover hay. He had too little alfalfa hay yet to make much show in the feeding barn. The lambs throve; they became very fat indeed and in May weighed 108½ lbs. In fact in all the years that lambs have been fed on Woodland Farm no such gain has since been secured, which simply shows that a greenhorn may do as well as an expert, if he has his heart in it and is earnest and careful. The boy had kept careful account of what the lambs had eaten so he knew what the gain had cost him. When he had figured it all up he found that he had made a clear profit from feeding these lambs of $115, the first real profit from Woodland Farm since his new venture in management. It was a small sum, yet mightily it encouraged him. And then he dreamed another dream, out there on the sunny side of the barn. Thinking it over, he said: "Some day we'll feed a thousand lambs on this farm." But he told no one that, not even his wife, for all would have smiled in derision, for had he not bought part of the hay that he had fed this first 200?

But there was more manure to haul out than ever before, and it was put where corn would be grown and where alfalfa might be expected to succeed, and more alfalfa was sown. Wherever the manure had been put out and the drains laid the alfalfa succeeded. Inoculation took care of itself on Woodland Farm after the first start, because of the use of manure made from alfalfa hay perhaps, and every

little field added to those first started succeeded in almost direct proportion to the amount of manure used and the thoroughness of the underdrainage.

The next winter 300 lambs were fed, then 350, then 350 again, and then a larger barn was built and 700 were fed. The work grew easier and easier; wheat was dropped from the rotation, and no more timothy seed was sown. Lamb feeding promised profit, so finally it was resolved that lambs would be fed and crops grown that lambs liked, and nothing else. Meanwhile Willis and the writer bent their backs energetically in the ditches, draining more and more land, and hiring men to dig what they could not. Charlie, too, growing up a stalwart boy, helped cheerfully, and the three brothers were full of faith. And yet neighbors smiled, and some there were to sneer. It is true that when the new barn was built with a mow that could hold 100 tons of hay men asked smilingly if we thought we could borrow money enough to buy hay enough to fill it, and went off laughing when we declared that we would fill it from our own alfalfa meadows some day. No one else in the country was trying to grow alfalfa, so far as we knew, no one else in Ohio, though there was some grown in Onondaga Co., New York. Well, we filled the barn at last, and had an overflow. We fed a thousand lambs as we had dreamed, and we fed 1,200. We had learned how at last. Lamb feeding is an art, a science; it is not yet all learned.

It had not all been smooth sailing, this lamb feeding. More than one disaster had overtaken us.

There had been bad years, low prices, diseased lambs, all sorts of troubles. Grimly we had held on. "We can't afford to change now," we declared. "We have made too many mistakes in what we are doing. To change now would be to lose all we have gained by making these mistakes; we don't have to make the same mistakes the second time." So we held on, confident that our scheme was a safe and reasonable one, based on alfalfa growing, the alfalfa fed to lambs, the manure put out for corn, the well enriched corn stubble sown to alfalfa, often with additional phosphorus and as much as possible of the corn and alfalfa fed back to lambs again.

But during these years we were in debt, a little at first, but steadily the debt grew. We owed for labor to dig drains, we owed for labor and materials to build fences and barns. We did all the labor that we could do with our own hands, but we were too impatient to wait to develop the place ourselves. "Farming either is or is not a business proposition," we declared. "If it is a safe business proposition this thing will pay some day, and if it is not we will break and be done with it. If we can't farm as a business proposition we prefer to break up trying it." And ever and often the writer, the older of the brothers, declared to Willis, his willing lieutenant: "It is only a question of one good year, just one good year, and the lambs will pay every dollar that we owe and we will have the ditches laid, the buildings built, the fields made fertile, and it will all be ours."

That year came when we had 1,200 lambs. We had learned how to feed them by this time, and they were as alike as peas, and ripe and fine as they could be. The commission merchants down in Buffalo had learned to watch for our lambs and to prize them. They had an alfalfa quality about them that no one could attain except he had alfalfa. We had fed them this winter altogether on alfalfa hay and ear corn, all grown at home, and we had hay left over enough to sell to our neighbors; some of whom needed hay with which to do their spring plowing. Well, we sold the lambs, one load at a time, and the checks came back and we laid them down on the bankers' counter. Now we owed no one in the world but this bank, but we owed it a lot of money. Steadily despite the fact that we had economized, had ridden in our old buggies and worn our old clothes, this debt had grown, and at last it had become a serious burden on our minds; it seemed incredible that it would ever be paid.

At last the last check had come. With a fast beating heart the writer laid it down on the bankers' counter. "Here it is. The lambs are all sold; is it enough to pay that note?" The banker smiled; he was a good fellow. "Yes, plenty to pay it, and some over," and he handed the note through the window, cancelled. The writer looked at it; how huge then the amount of it seemed! He tore off the signature and turned anxiously again. "Tell me," he asked, "how much is there left?" The banker figured for a moment and presented with a smiling

face the bank book, where on the right side of the page was a credit balance of $800. The debt was paid. The tiles were laid, or a lot of them were laid at any rate, the barns were built, the home was paid for and there was actually money in the bank! The writer feels that there are many happy days ahead of him, but never again expects to experience the relief, the thankfulness, the joy that came to him when his first victory was won for Woodland Farm, and the brothers fully shared the feeling.

The writer jumped into his old buggy and drove home, his face wreathed in smiles and his heart singing a joyous song. As he neared his home the thought came: "Why, I will have some fun with the sweetheart. I will make believe the thing has ended badly. I will tell her some sort of story to deceive her, just at first; afterward I will undeceive her." But when he drew near the little cottage she stood there in the open door waiting for him to come, looking out at him, all unconscious, yet on her face was revealed all that the thing meant to her, and his heart became suddenly very tender and it came over him with a shock of understanding. "Why, I never dreamed that the girl cared like this. Did she perhaps wonder whether the home would be sold, the place where she had planted flowers and vines, the place where her babies were born? Where she had been so brave, so strong, so patient and helpful all these years, and yet cared so much as this?" So all his foolish stories were put aside and he told her the glad truth.

And what had the farm done that year? After all the items of sales and expenditure were footed up it was found that the same land that had yielded our father less than $800 had yielded us a net profit of more than $2,500. Alfalfa had worked this miracle. It had given us the hay with which to feed the larger number of lambs, and through the soil enrichment that it had given the fields it had made possible the heavy crop of corn that we had fed to the lambs, so really to alfalfa should be credited both corn and hay. Further, alfalfa had made it possible to continue feeding lambs. When we were beginning, and were almost without alfalfa hay, we had fed largely of oilmeal and wheat bran to balance up the ration. This was necessary; experiment proved that. Without plenty of digestible protein in the ration the lamb does not gain much. We made good lambs through the aid of the bran and oilmeal, but it cost us too much. When finally we had our own alfalfa hay to furnish protein we made two lots of lambs. They had equal merit in the beginning as near as we could tell, for they were of the same bunch, selected to get two like lots. The one pen was fed with timothy hay, with some clover, shredded corn fodder, corn, wheat bran and a little oilmeal. They grew well, but each pound of gain made cost us 6½c. The second lot was fed with good alfalfa hay and corn only. With them the cost of gain was only 3½c. As the price of lambs declined during the nineties we would have had to give up had not alfalfa come to our rescue.

At the present writing (1909) we are feeding some 1,450 lambs, with about 150 ewes and lambs, and we could as readily feed 2,000 or more if we had more shelter for them.

Woodland Farm is larger now; the alfalfa has crowded the line fences back a little. It contains 320 acres and is devoted mainly to the growing of corn and alfalfa. During the summer of 1908 corn was grown on 90 acres of alfalfa sod. This field had been twice sown to alfalfa, with intervals when it was planted in corn. The last period of alfalfa was a 6 year period for part of the land and a longer period for the remainder. During the 6 years there were taken off at least 20 crops of hay, certainly 20 tons of hay to each acre. During this time no manure was put on the field, but on parts of it phosphorus was applied in the shape of acid phosphate, about 300 lbs. per acre or maybe a little more. The great crops of hay taken continually off of this field disturbed our mother, who finally spoke in sorrowing tones to the writer, thus: "Joey, I am worrying about that alfalfa field." "Why, mother?" "Because you do not manure it. You haul off hay and haul off more hay and it seems to me you actually have hollowed the land out so that it is lower than it used to be. I think of what your father would say if he could see it. Why don't you put some manure on it, boy?"

I assured her that I could not believe that the land was really getting poor, and that we were putting the manure out carefully on land that we knew was

poor, and she said no more. When we plowed the land in the winter of 1908-09 it seemed more mellow and friable than usual, so we plowed it deeper than it had usually been plowed. And when we disked it up in the spring it was most evident that the field had changed its character somewhat, so loose, mellow and friable it seemed. We resolved to make an effort to beat our record for corn raising, so we planted with care. The seed was good and had been tested. We got nearly a perfect stand over much of the field and all summer gave it good culture. There was a most serious drouth late in the summer, which doubtless cut down our yield somewhat. Yet 50 acres of that field made for us a little more than 100 bushels of shelled corn per acre and the entire 90 acres only fell a little short of making 9,000 bushels. This result astonished us, as the field had in olden times yielded only about half that amount. In truth the alfalfa had built it up far beyond the fertility that it had had when a "virgin soil."

Let us briefly examine this miracle and see how it was accomplished. In the first place it is probable that this especial field has in it already about as much potash as it needs for large crop production, since it is a glaciated soil. Most of the field is well supplied with lime; in truth one can find small pebbles of limestone sticking all through the soil. Thus it was sweet, and the alfalfa revels in sweet soil, alkaline, not acid. So the alfalfa was at home there. Then the land had been thoroughly well underdrained; thus it was full of air. Alfalfa bacteria

thrive in soils rich in lime and full of air; they perish in a wet sour soil. Thus the alfalfa filled all the soil with its rootlets, going down often as far as 6 feet, no doubt, and numberless millions of bacteria working there were storing the soil with nitrogen drawn from the air. The phosphorus supply may have been somewhat deficient; we bought phosphorus for part of the land and added that. Then the land was plowed; the plow cut off millions of those big roots and left the top soil one mass of roots, with also many little rootlets and many leaves and stems that had fallen down. And the subsoil was made porous by being honeycombed by millions of the tap roots, so the air penetrated all the more easily. Thus it is seen that conditions for a big corn crop were almost ideal.

It would be an interesting thing to know just how much richer Woodland Farm is than it was before alfalfa began to grow upon it. It is safe to say that the alfalfa, yielding on the average 30 tons of hay per year for the past ten years, has added to the soil plant food worth at least $3,000 each year, counting the manure that has been returned and the work of the roots; probably this is an underestimate, in fact. Once we racked our brains to find manure enough, and never did find enough. Now we rack our brains again to find time to haul out the manure that is made upon the farm. Gathering fertility by the use of alfalfa is like rolling a snowball—the farther you roll it the faster it gathers. This would not be true if the hay was sold off of the farm, but

it is certainly true when the hay is fed and the manure carefully saved and returned, to make another spot rich for alfalfa to grow upon.

The story of Woodland Farm is only half told; the rest lies in the future. We have some acres that yield as much as 6 tons of hay each year, yet the average of the whole farm is less than 4 tons. Thus we are not yet inclined to boast of our success with alfalfa. We now are proceeding to try to spread these good yielding areas. What is the secret of the lands yielding alfalfa so well? Perhaps we do not know the whole story, but here is what we can readily observe. One of these spots is a round hillock. It is a strong, tough, tenacious limestone clay. Sticking all through that clay are bits of limestone pebbles, as large as grains of corn, as large as a man's foot, and of all sizes. These pebbles are of soft magnesian limestone. They readily decay and keep the land very sweet. Alfalfa roots seem to like actually to touch carbonate of lime. On that hillock the alfalfa never gets old. It is one of the most productive spots on the farm. On it our father put much manure, for it was, when he bought the farm, extremely unproductive. We have not manured here for many years.

On other lands we find the limestone pebbles all dissolved away in the surface soil. When we dig down two feet we find them in abundance, but on the surface there are none. Here we are assuming that lime is needed, and are putting on more carbonate of lime, buying ground and unburned lime-

stone and applying it at the rate of about 5 tons to the acre. Probably that is too little; it is yet too early to know. We feel sure that when we have made the drainage right and the lime content right we will grow as much alfalfa over all the farm as we now grow on those favored spots. Then we can proudly boast, sure enough! Then we can say: "From 100 acres of land we harvested 500 tons of alfalfa hay." It may take time to reach this condition. It may not even come in my day. But we have boys and to these boys we bequeath the ideal, the task, and to them will fall the pleasant duty of spreading these spots of gloriously beautiful alfalfa, rich and productive beyond anything else that could be sown.

It may be of interest to know something of the present system of farming on Woodland Farm. Let us begin with the alfalfa sod that is to die that corn may live. It is plowed usually in November and during the winter. Perhaps the field was mown off late, four cuttings being taken from it, in anticipation of its impending destruction. We find that late cutting is bad for the alfalfa and do not usually cut it later than early in September. This field to be devoted to corn then will be mown off late, as it does not matter how much the roots are weakened. Usually we plow with very strongly built walking plows. We put two wheels on the beam, well in front; one wheel runs in the furrow, the other on the unplowed land. These wheels hold the beam rigidly in place, and thus the plow runs well; a boy can man-

age it if the thing is set right. We keep the plows sharp. The plowman carries a file and often lifts the plow out of the ground and sharpens it well. The land is plowed deep, from 7 to 10″, and we hope ultimately to plow much deeper than that. We aim to get the land all broken before mid-winter, so that the frosts may work on it. No manure is used on alfalfa sod. It is disked and fitted for corn which is planted usually about May 5 in checks. This corn is as well cultivated as we know. Often in the early part of the season the alfalfa roots will grow, especially if the season is wet, and the field will look not a little green. This does not disturb us in the least, for after the corn cultivation begins the alfalfa soon weakens and mostly disappears. Some stray plants will escape destruction and will live over, even for two or three years of corn. This is all the better, since thus the inoculation is safely carried over. The corn has as clean cultivation as we can give. We discourage weed seeding as much as possible. We have learned that that enemy of alfalfa, fox-tail or pigeon grass, can be surely eradicated in one year by not letting a stalk of it make seed.

The corn is cut and shocked. Before winter it is husked and the folder set up, two shocks in a place. We cut our corn 12 hills square; at present our hills are 42″ apart. We find corn to thrive wonderfully on alfalfa sod. The second year will usually find this land yet in corn. This time as much manure from the stables and sheep barns as can be found will be put on. Even with this manuring

we do not expect quite so good corn as we had when we grew it on alfalfa sod. As before, clean cultivation is given. We are especially careful to destroy all fox-tail grass before it seeds.

This land is now to be sown to alfalfa. If it needs lime that is applied as convenience suggests, whenever the teams are idle and the land is hard enough to drive on. We use finely ground raw limestone rock, not burned. We use about 4 tons to the acre of this. It cost us only $1.25 per ton on cars. The land is plowed as deep as the plows will run, making the furrows narrow. We would plow 24″ deep if we could do so. Some day no doubt we will begin subsoil work, and expect that to pay well. We like to do this plowing a month or more before time to seed alfalfa, so that the earth may settle well together again. In April we disk and prepare the land with some care, but not attempting to make any "ash heap" or "onion bed," as some advise, only a little better seedbed than one would make for corn. About April 10 we begin drilling. We use a fertilizer drill that sows fertilizer, beardless spring barley and alfalfa seed. Of barley we sow 2 bushels to the acre; of alfalfa seed, 15 to 20 lbs.; of fertilizer (usually plain acid phosphate, sometimes bone meal) we use 300 to 500 lbs. per acre. We think it probable that the more we enrich the land the greater our profit is. We let the alfalfa seed fall in front of the drill sometimes, at other times behind the drill, according to the condition of the soil. If moist we do not roll but follow the drill with a plank drag. If

the land is dry and cloddy we use a roller to compact it and to leave the surface smooth so that the mower may run over it readily. We do not inoculate, since all the farm is now filled with alfalfa bacteria. The alfalfa comes up with the barley and all grow together till the barley has come into head; before grain has formed in the heads it is mown off and all made into hay. Barley hay is exceedingly good hay, though not so good as alfalfa hay, of course. After this cutting the alfalfa comes on rapidly and in about 45 days, or a little less, it also is cut and a crop of hay taken off.

We judge of the time to cut this young alfalfa altogether by the condition of the growth, not by the bloom. When small shoots appear at the base of the stems, down by the ground, as though it was ready to make a new growth, then it is to be cut, and not before that time. If cut before these shoots or buds appear, the alfalfa is very greatly weakened and sometimes is destroyed. After this cutting the alfalfa is left religiously alone; it is never pastured nor mown nor tramped in any way during the fall or winter. The fall growth of about a foot or a little more is worth a very great deal to the plant, in some way or another; it helps hold the snow and makes it winter better. The next year the alfalfa shoots out as soon as the frost is out of the earth.

Alfalfa fields are sacred ground on Woodland Farm, and never unless by accident is an animal permitted to tread upon them. It is especially important that no stock go upon them in the spring

when the young alfalfa is pushing up; even though the alfalfa might be destined for pasture everything is kept off until it has made good growth, and is nearly knee high and almost come into bloom before stock is turned in. Gloriously beautiful the fields become in May, and as June draws near we watch them to see how nearly they are approaching harvest. We have long ago learned not to regard the blooming of the alfalfa as being an essential indication of maturity, but only we suspect that it is ready for cutting. We get down upon our knees in the field, and parting the stems look to see whether small buds have appeared at the surface of the ground. If these buds or shoots are pushing out, showing that the plant is ready to make new growth, then the mowers come out, three of them, each cutting swaths 6′ wide, and with merry rattle the beautiful green forage is laid low.

Not much use is made of the tedder on Woodland Farm, since it shatters off the leaves too much, although sometimes it is employed when the crop is very succulent and heavy. Before the alfalfa is dry enough for the leaves to shed off, the rake is started and the hay gathered into small windrows, which are then piled into slender but fairly tall cocks by the use of the hand fork in the old-fashioned way. Rather a jolly time haymaking is, with all the men and boys on the place busy in the field, with merry callings to and fro and sometimes the note of a song, yet it is a busy place too. Seldom can the hay be drawn in the same day as it is cut down, and not al-

ways on the next day, but as soon as it is dried it is placed on broad, low-platform wagons, each bed 16′ long and 7′ wide, with tight board floors; and taken to the barn where it is unloaded by horse forks. The farm possesses 7 of these wagons, so that each evening it is the daily duty to load up the 7 wagons with from 10 to 14 tons of hay, which are then drawn under shed ready to be unloaded in the morning. Not much is doing in the alfalfa meadows in the forenoon; then is the time chosen for work in the corn fields, and cultivators are pushed steadily. These two crops, corn and alfalfa, constitute almost all that is grown on Woodland Farm, excepting a few acres of soy beans and the blue grass pastures, but as the alfalfa is cut three times during the season, and the corn cultivated at least five times, there is no difficulty in keeping everyone busy.

The writer makes no apology for having devoted so much time to the operations on Woodland Farm, since he feels that in a sense this is a pioneer farm, and fairly prophetic only, of what will be very common throughout all the region of the corn belt. Very certainly these two crops, corn and alfalfa, are by far the most profitable of any, and do most conserve the fertility of the soil, do best nourish all manner of farm animals, do most surely build the fortunes of the farmer. Deeply buried in the soil of the fields, the alfalfa roots know nothing of the vicissitudes of winter; as certainly they put out green as leaves upon the oaks in spring, and drouths that wither up ordinary meadows have little effect upon them.

Wheat, oats, potatoes, timothy grass and a hundred other things are uncertain, affected vastly by the vicissitudes of the weather. Alfalfa once rooted in dry rich soil has the permanence of the wild native things. Corn also planted upon alfalfa sod well cultivated mocks at seasons, for floods affect it not, since the land must perforce be well drained, and drouths and heats that sear other vegetation pass it by, leaving it fresh, green and undismayed. These two crops then are destined not to free the farmer from labor, for they bring abundant labor to him, but to take away from him the cares and perplexities incident to the growing of uncertain things.

HISTORY.

The world is very old. For more ages than we dream men have lived and loved, toiled, sown and reaped. The history of the race is written in the form, variation and characteristics of animals and plants much more than in tablets of stone or pieces of clay. Would you ask how long men have lived on earth? Ask when first hornless cattle were kept. Records in Egypt show them to have been common thousands of years before the time of Christ. Ask when sheep were first tamed and their fleeces developed. The very race of wild sheep has perished from the face of the earth and the sheep of Abraham's day were highly developed. Ask when wheat was taken from being a wild grass and made a cultivated plant; when the banana ceased to have seeds; the apple gathered sweetness and the vine began to hang down with luscious clusters of purpling grapes. Ask, too, when it was that animals became the subjects and friends of men; when men began to feed them, to gather forage for them, to cultivate plants for them, to perceive which plants were the best plants and which best fed the animals. Ask, too, when men first saw that soils grew worn, that certain plants fed soils, that other plants caused them to become infertile.

All these things happened many thousands of years ago. The best things done by men are older than recorded history. The taming of the ass, the taming of the horse, the taming of the cow, the development of the milk-giving powers of the cow, the caring for sheep and goats, the breeding of sheep for wool, the spinning of wool and flax, the melting of ores—all these primal things happened long centuries ago. Since historic times man has learned very little indeed that he needed to know; the important, primal, essential things were all worked out before men began to write upon stone and upon parchment.

It is not certain that there exists today any wild alfalfa. There are places where some has escaped from cultivation and gone wild, but all alfalfa, so far as known, has so changed its form from what it would be in the wild state that it is doubtless bearing in its nature the very marked signs of the moulding hand of man. For example, all alfalfa so far as known today needs to be cut off from time to time to keep it in thrift. No wild plant requires that. Alfalfa that we know reflects a long line of civilizations, reflects the habits of people who have kept cows and donkeys and sheep and horses, kept these and fed them, carrying their forage to them on men's backs for ages untold. It requires no effort of the imagination when looking out upon an alfalfa field to picture the fields from which it sprung through the ages past. The little fields fair and green and fertile under hot glowing desert skies mostly. Little fields

for the most part walled often with walls of stone or of sun-dried bricks, lined with little canals of cool water with overhanging trees, fig trees or almonds or palms, and brown men and women, lithe and strong, coming to cut the green meadow with curved sickles and scythes, gathering it in sheaves and carrying it on their backs through gates in the walls to the animals eagerly awaiting it in the enclosed corrals or stables. Alfalfa was developed in dry regions. It came, very likely, from southwestern Asia through Persia to Arabia, whence it got its name alfalfa, which simply means the best forage. The Persians grew it finely. Down along the rivers of Babylon in ancient Babylonia alfalfa was a standard crop, most likely. Those river valleys are rich in lime and alkaline in their reaction, admirably suited to alfalfa culture, and there under irrigation alfalfa undoubtedly throve. The one reference to alfalfa in the Bible is found in the fourth chapter of the book of Daniel where in the thirty-third verse it is related of the king:

"The same hour was the thing fulfilled upon Nebuchadnezzar: and he was driven from men, and did eat grass [alfalfa] as oxen, and his body was wet with the dew of heaven till his hairs were grown like eagle's feathers and his nails like bird's claws. And at the end of the days, I Nebuchadnezzar lifted up mine eyes unto heaven, and mine understanding returned to me, and I blessed the Most High, and I praised and honored Him that liveth forever, whose dominion is an everlasting dominion, and His kingdom is from generation to generation."

The truth probably was that old Nebuchadnezzar, rich, spoiled, feasted and wined till he became insane, was turned out to graze in an alfalfa field till on this simple and nutritious diet his body was re-

newed, filled with health and vigor, when his reason returned and of course he did what any healthy man will do daily, blessed the Most High and praised Him and was humbled and glad once more.

It is related that in the old kingdom of Babylonia wheat would yield 200 fold and sometimes 300 fold, which plainly indicates that it must have been sown thinly in drills upon alfalfa sod, irrigated from the canals with which that country abounded, and probably weeded and cultivated by slave labor.

About 500 years before Christ the Persians invaded Greece. Now, Greeks are stubborn folks, or were in those days, and many were the battles before the Greeks were even in part conquered. The Persians, aided by Greek factions and tribes, doggedly toiled steadily onward, taking city after city. Wherever they went they had chariot horses to feed and cattle —bulls, so legend says—for fighting, and cows no doubt for helping feed the army. With curious mixture of martial and agricultural zeal they brought with them alfalfa seed and wherever they conquered foothold they sowed alfalfa. An army travels, and fights, on its belly, so it was a mighty help to the Greeks to have the aid of the alfalfa. And without doubt it was eaten by the soldiers as well, since green succulent alfalfa has always been boiled and eaten as greens or pottage. Unhappily the Persians sent away hosts of the Greek subjects as slaves to Asia, else when they had gone on the people might have been almost benefited by the war, since alfalfa fields were left in the wake of the army. It must be

remembered that much of the land of Greece is formed from the decay of limestone and marble. Thus filled with carbonate of lime it is naturally fitted for alfalfa culture as well as for the production of such magnificent men as the Greeks undoubtedly were.

From Greece alfalfa spread into Rome, just when we do not know. The first real farm books were written in the first century after Christ. One L. Junius Moderatus Columella, born in Spain but living most of his life in Italy, wrote twelve books which he called "De Re Rustica." These books were written about the year 56 A. D. It would seem from dipping into the pages of Columella that about as much was known then of agriculture as is known today. Indeed, they knew then many things that we do not know today, and agriculture has lost many picturesque details by the pruning away little by little of agricultural fancies, by the accumulations of stern facts.

But however much we may smile at some of Columella's account of ancient Roman agriculture, we will respect him for his account of alfalfa and the way to grow it. Many forage crops are mentioned by Columella—medic (alfalfa), vetches, bitter vetch, chick pea, barley, oats and wheat.

Speaking of the various sorts of fodders he says the herb medic (alfalfa) is the choicest, because when it is sown it lasts ten years. He continues:

It can bear to be cut down four times, sometimes also six times in a year, because it dungs the land. All emaciated cattle what-

soever grow fat with it because it is a remedy for sick cattle, and a jugerum of it is abundantly sufficient for three horses the whole year. It is sown as we shall hereafter direct. About the beginning of October cut up the field wherein you design to sow medic next spring and let it lie all winter to rot and grow crumbly. Then about the first of February plow it carefully a second time and carry all the stones out of it, and break all clods. After about the month of March plow it the third time and harrow it. When you have thus manured the ground, make it in the manner of a garden, into beds and divisions ten feet broad and fifty feet long, so that it may be supplied by water with paths and there may be an open access for weeders on both sides. Then throw old dung upon it and sow in the latter end of April. Sow it in such a proportion that a cyathus of seed may take up a place 10 feet long and 5 feet broad. After you have done this, let the seeds that are thrown into the ground be presently covered with earth with wooden rakes. This is a very great advantage to them because they are very quickly burnt up with the sun. After sowing, the place ought not to be touched with an iron tool, but as I said it must be raked with wooden rakes, and weeded from time to time lest any other kind of herb destroy the feeble medic. You must cut the first crop of it somewhat later, after it has put forth some of its seeds. Afterwards you are at liberty to cut it down as tender and as young as you please after it has sprung up and to give it to horses, but at first you must give it to them more sparingly until they be accustomed to it, lest the novelty of the fodder be hurtful to them, for it blows them and creates much blood. Water it very often after you have cut it. Then after a few days when it shall begin to sprout weed out of it all plants of a different kind. When cultivated in this manner it may be cut down six times in a year and it will last ten years.

That instruction bears evidence of much familiarity with the alfalfa plant. It must not be cut too soon the first time, not till some seeds have formed. It is true here that young alfalfa is destroyed oftentimes if cut before the young shoots have put out at the base of the stems. Not having observed this perhaps the old alfalfa growers judged by the state of bloom or seeding when it should be cut. Note that Columella says "it dungs the land." Thus early they knew the practice of farming with legumes,

and that alfalfa was the best of the legumes for this purpose of enriching soils.

Note too that he found it a good food for horses. It is said that the chariot horses were fed on alfalfa hay, and the colts destined to become war horses were raised largely on it because it made them larger, heavier and more impetuous.

From Italy alfalfa naturally spread wherever the Roman farmer colonist penetrated, through France, Spain, England and doubtless Germany. It may be that Spain also received alfalfa from Africa through the Moors. The name alfalfa comes from the Arabic and means the best forage, and this name the Spanish people adopted. Through the introduction of the plant in America by the Spanish colonists and our taking it from them on our Pacific coast we get the name alfalfa. In France, England and most other European countries, and in Utah and formerly through all our eastern states, the name lucerne is in common use. This name comes from a river valley in northern Italy.

Alfalfa throve in Italy, in much of Spain and in parts of France. Where it throve no other forage plant could compete with it. It was introduced long ago into England and there it throve in spots. It was much extolled by some, its planting advised, yet it never became common and today is seldom seen in extensive use on the British Isles. It was brought to America in two ways, from Spain to Mexico, Peru, Chili, Argentina, from Mexico to Texas, New Mexico and California; later from Chili

to California in 1851, which marked the really important step in alfalfa growing in America.

The other source was the bringing of lucerne seed to the eastern states of America from England, France and Germany early in the history of American colonization. In the eighteenth century many men were experimenting with lucerne in Virginia, New York, North Carolina and doubtless other states. Some of them succeeded quite well and many of them doubtless failed. We know now the reason why many failed. Then the behavior of lucerne was a mystery to the farmer. We had not learned then the intimate connection between alkalinity of soil and presence of abundant carbonate of lime and alfalfa culture. It is all very easy to explain this now—how alfalfa came from alkaline soils rich in lime down in Persia, into the alkaline plains of Babylonia, to the limestone soils of Roman lands, to the soils of Greece built on marble decay, to the limestones of southern France, to the alkaline soils of semi-arid north Africa, to the soils rich in lime and alkalies in Spain, thence to similar soils, yet richer in lime, in Mexico, Chili, New Mexico and California. In England soils vary immensely as regard their lime content. Some are very rich in lime; on these lucerne throve: in others lime is very deficient; here it failed. In France there is found a similar variability, so also there were found areas that grew good lucerne, and others that grew none at all. In eastern America, on the other hand, nearly all soils were from the first settling of the country deficient

in lime and thus unfitted for alfalfa. Yet the soils as our fathers found them were sweeter than they are today, and thus we often hear old men relate that in their boyhood their fathers grew lucerne and that their daily task was to cut it and feed it to the cows; this on land that will not today unaided grow alfalfa at all.

In reading over the written accounts of how to grow lucerne published in the last century one is amazed to find how much the authors knew of the habits of the plants, and as much astonished to perceive that few if any of them understood the vital connection between alfalfa and a large percentage of carbonate of lime in the soil. One of the good old books on agriculture is "The Dictionary of the Farm," by the Rev. W. L. Rham, Vicar of Winkfield, Berkshire, who died in 1843. The article on lucerne is strikingly good, so good, indeed, that had the author known two facts of which he seems to have been unaware there would have been left little to add. He evidently had not traced the relationship between thrifty lucerne and a strong lime content in the soil, nor had he seen the harm that comes to lucerne when it is mown off too early, before it has made sufficient growth to start the little shoots at the base of the stems. Ignorance of the latter fact is very universal in England at the present time and leads to much lack of thrift and falling away of the alfalfa plants that are usually cut with the scythe bit by bit, and fed to horses green, just as Rham advised. The writer has indeed pointed out to Eng-

lish farmers that the lower sides of their lucerne fields remained thrifty after the upper ends were half destroyed, just because of the fact that the man with the scythe commenced on the upper end before it was time to cut the immature plants, and by the time he had reached the bottom of the field it was sufficiently mature, so remained in vigorous condition.

The article follows from "Rham's Dictionary of the Farm," published in 1853:

Lucerne is a plant which will not bear extreme frost nor superabundant moisture, and its cultivation is therefore restricted to mild climates and dry soils; but where it thrives its growth is so rapid and luxuriant that no other known plant can be compared to it. In good deep loams lucerne is the most profitable of all green crops; when properly managed the quantity of cattle which can be kept in good condition on an acre of lucerne during the whole season exceeds belief. It is no sooner mown than it pushes out fresh shoots, and wonderful as the growth of clover sometimes is in a field which has been lately mown, that of lucerne is far more rapid. Where a few tufts of lucerne happen to be, they will rise a foot above the surface, while the grass and clover which were mown at the same time are only a very few inches high.

Lucerne, sown in a soil suited to it, will last for many years, shooting its roots downwards for nourishment till they are altogether out of the reach of drouth. In the driest and most sultry weather, when every blade of grass droops for want of moisture, lucerne holds up its stem, fresh and green as in a genial spring The only enemies of this plant are a wet subsoil and a foul surface. The first is often incurable; the latter can be avoided by good cultivation.

It is useless to sow lucerne on very poor sands or gravel or on wet clays. The best and deepest loam must be chosen, rather light than heavy but with a good portion of vegetable earth or humus equally dispersed through it. If the ground has been trenched, so much the better; and if the surface is covered with some inferior earth from the subsoil it will be no detriment to the crop, for it will prevent grass and weeds from springing up and save much weeding. The lucerne will soon strike down be-

low it. It is not a bad practice to cover the lucerne field with a coat of coal ashes or poor sand, merely to keep down the weeds, where this can easily be done.

The soil in which it is intended to sow lucerne seed should be well prepared. It should be highly manured for the two or three preceding crops and deeply ploughed, if not trenched. It should be perfectly clean, and for this purpose two successive crops of turnips are most effectual. The turnips should be fed off with sheep. In the month of March, the land having been ploughed flat and well harrowed, a very small quantity of barley, not above a bushel to the acre, may be sown, or rather drilled on the ground, and at the same time from 30 to 40 lbs. of lucerne seed sown broadcast and both harrowed in and lightly rolled. If the land will not bear to be laid flat without water-furrows, it will be useless to sow lucerne in it.

As the crop comes up it must be carefully weeded: no expense must be spared to do this effectually, for success depends upon it. When the barley is reaped, the stubble, which will probably be strong, should be pulled up by the hand hoe, or by harrowing, if the plants of lucerne be strong, and at all events the ground must be cleared of weeds. It must not be fed off with sheep; they would bite too near the crown. Lucerne should always be cut as soon as the flower is formed. If it is kept clear of weeds the first year, there will be little difficulty with it afterwards, when the roots have become strong. The second year the lucerne will be fit to cut very early, and in a favorable season it may be cut four or five times. After each cutting it is useful to draw heavy harrows over the land, or an instrument made on purpose resembling harrow teeth, the teeth of which are flat, and cutting the soil like coulters. It will not injure the plants, even if it divide the crown of the root, but it will destroy grass and weeds. Liquid manure, which consists of the urine of cattle and drainings of dunghills, is often spread over the lucerne immediately after it has been mown, and much invigorates the next growth; but if the land is rich to a good depth this is scarcely necessary. The lucerne will grow and thrive from seven to twelve years, when it will begin to wear out, and, in spite of weeding, the grass will get the upper hand of it. It should then be plowed up, all the roots carefully collected and laid in a heap with dung and lime to rot, and a course of regular tillage should succeed. The same land should not be sown with lucerne again in less than ten or twelve years, after a regular course of cropping and manuring.

Cattle fed upon lucerne thrive better than on any other green food. Horses in particular can work hard upon it without any corn, provided it be slow work. Cows give plenty of good milk

when fed with it. In spring it is apt to purge cattle, which with a little attention is conducive to their health. If it is given to them in too great quantities, or moist with dew, they run the risk of being hoven. These inconveniences are avoided by giving it sparingly at first, and always keeping it twenty-four hours after it is cut, during which time it undergoes an incipient fermentation, and the juice is partially evaporated: instead of being less nutritive in this state, it is rather more so.

An acre of good lucerne will keep four or five horses from May to October, when cut just as the flower opens. If it should get too forward, and there be more than the horses can consume, it should be made into hay; but this is not the most profitable way of using it, and the plant being very succulent, takes a long time in drying. The rain also is very injurious to it in a half dry state; for the stem is readily soaked with moisture, which is slow in evaporating. The produce in hay, when well made, is very considerable, being often double the weight of a good crop of hay.

Many authors recommend drilling the seed of lucerne in wide rows, and hoeing the intervals after each cutting. This is the best way with a small patch in a garden, and when only a little is cut every day; but in a field of some extent, the lucerne, when once well established and preserved free from weeds by hand weeding the first year, will keep all weeds down afterwards, and the heavy harrows with sharp tines, used immediately after mowing, will pull up all the grass which may spring up. No farmer ought to neglect having a few acres in lucerne on his best land.

Note carefully that Rham says, "If the ground is trenched so much the better, and if the surface is covered with some inferior earth from the subsoil it will be no detriment to the crop." The fact is that earth from the subsoil often, in fact usually, has in it much more lime than surface soil, so that bringing it up is sometimes equivalent to a fairly good liming.

It is a little difficult to explain the general neglect of alfalfa in England, since there are many soils there admirably suited to it and almost any of the well-drained English soils would now grow it well if they were well limed and enriched with even bare

mineral fertilizers. It may be the uncertain weather of British hay-making times has had a deterrent effect to the alfalfa growers, though it would seem more probable that the mere lack of knowledge of the subject was the main factor responsible for the fewness of alfalfa fields there. The writer has seen as thrifty alfalfa in Kent as he has seen anywhere in the world, and has marvelled at its small extent till he was told that the entire crop was fed green to the work horses.

In America a number of men wrote enthusiastically of the lucerne plant. It is certain that George Washington grew it at least to some extent, and Thomas Jefferson, on a kindlier soil, grew it so well that in one of his letters he mentions the joy that contemplation of his fields of lucerne gave him. To-day no alfalfa is grown on either of these farms, nor in their neighborhood. Is it that eastern farms are less fertile now, or is it that their owners are less prudent, enterprising and careful?

In New York Robert Livingstone wrote of it and many men experimented with the plant, some with success, some without. In few localities in the eastern states, however, did it gain a permanent foothold. There were several reasons for that. One principal reason was that alfalfa does not mature seed along the Atlantic seaboard except during very dry summers; thus it was necessary to import fresh seed from Europe constantly at considerable trouble and expense. Then the plant's nature was not understood, its lime requirement was not known, much

land was badly drained and fields were ruined by not being cut at the proper time. Thus the enthusiasts gradually became discouraged and it became a settled belief that lucerne could not profitably be grown in eastern America outside of a few restricted neighborhoods. As indicating the sentiment of the friends of alfalfa in those days we quote a letter published in the "American Farmer" of 1823, the letter copied from the "New Brunswick Times." The method of sowing advised is curious, to sow in the spring with fall rye, and there may be a hint in this for others living today in similar conditions. Note the excessive price of the seed—50c per lb., or $30 per bushel. The letter written by "A New Jersey Farmer" follows:

It may materially promote the interests of agriculture to offer through the medium of your paper a few remarks on the culture of lucerne. This article (frequently denominated French clover), I have found by experience to be not only one of the most convenient, but also the most profitable of any grass which can be cultivated. It vegetates quicker in the spring than any other grass, it resists the effects of drouths, it may be cut four or five times in the course of the season, and it will endure for at least twelve years without being renewed. Of all other grass it is the most profitable for soiling. I am fully of opinion that one acre properly got in would be sufficient to maintain six head of cattle, from the first of May until November, for before it can be cut down in this way, the first part of it will be ready for the scythe. English writers have recommended the drill system for this article, but in this climate I have found this to be entirely fallacious. The proper mode to be adopted is to have your land in good order, to sow it broadcast, and to get the seed in during the month of April or May. The plan I would recommend would be to sow fall rye at the rate of 15 to 20 pounds to the acre with it. The effect of this is that the rye vegetates quickly, and serves as a nurse to the young grass against the heat of the scorching sun, and by the time the grass attains sufficient strength to protect itself, say in four or five weeks, the rye withers and apparently

dies. In the spring, however, the rye will again come forth mixed with lucerne, will add much to the quantity on the ground, and prove a most excellent feed for cattle. The rye cut green in this way and before getting into seed will admit of being cut two or three times in the course of the season, with the lucerne before it decays.

The kind of soil most suitable for this culture is a dry mellow loam, but a sandy or clay loam will also answer, provided it is not wet. In a favorable season, the lucerne may be cut the next fall after sowing. After the first season you may generally begin to cut green for cattle by the first of May, which saves your young pasture and is in every respect a very great convenience, as hogs and every description of animals devour it with equal avidity. Backward as this season has been, I have been furnishing a copious supply every day to seven cattle, since the 5th of May. The seed can be procured at Thornburn's or other seed stores in New York, at 40 to 50c per pound.

The following notes on the culture of alfalfa and sainfoin are from a book called "Practical Farmer" published in 1793 by John Spurrier and dedicated to Thomas Jefferson. Mr. Spurrier was a transplanted English farmer. It is curious to note how nearly he came to knowing how to grow each of these crops, and how vitally he failed to grasp the truth that these plants thrive on "gravels" when these gravels are composed of limestone pebbles, not necessarily when they do not! This quotation is presented through the courtesy of J. M. Westgate:

Saintfoin took its name from the French; for the word Saintfoin, translated into English, is Holy-Hay, which name they gave it from its excellent nutritive quality.

There may be more benefit reaped from this grass than any other; as you may get a very great crop in the most dryest land, on hills, gravels, sands, or even barren ground; and it will so improve all those lands in such an extraordinary manner that they will bring great crops of any sort of grain after it.

The stalks of the plant in poor land will be two feet high, and in rich land it will grow as high as six feet. It has tufts of red flowers, of three, four, or five inches in length of the honeysuckle kind: they are so beautiful and sweet that I have seen

them much esteemed in a garden and called the French honeysuckle.

This plant will make twenty times the increase in poor ground than the common turf; and this is owing to its having a long perpendicular root called tap roots, as well as numbers of horizontal ones; the perpendicular ones sink to a great depth to attract its nourishment. The length of this root is scarce to be credited by any but those who have seen it; I have drawn it out of the ground near fourteen feet; and some have told me that they have traversed it to double that length. This is the reason I presume why this plant will bear drouth, when all other grasses have been burnt up by the excessive dryness of the season. I have at one cutting got two tons of this hay per acre.

Cold, clay, or wet land is not suitable for this grass, as it would chill and rot the roots. The long root of Saintfoin has near the surface many horizontal roots issuing from it, which extend themselves every way; there are of the same kind all the way down, as the roots go, but they grow shorter and shorter all the way.

Any dry land may be made to produce this valuable and useful plant, though it be ever so poor; but the richest and best land will produce the greatest crops of it.

The best method of sowing it is by drilling, but the earth must be very well prepared and the seed well ordered, or else very little of it will grow. The heads of these seeds are so large and their necks so weak, that if they be above an inch deep, they are not able to rise through the incumbent mould, and, if they are not covered, they will be malted; that is, it will send out its root while it lies above ground, and be killed by the air.

The best season for planting it is the beginning of spring; and it is always strongest when planted alone.

If barley, oats, or any other grain sown with the saintfoin, happen to be lodged afterwards, it kills the young saintfoin. The quantity of seed to be drilled or sown broadcast upon an acre of land will depend wholly on the goodness of it; for there is some seed, of which not one in ten will strike; whereas, in good seed, not one in twenty will fail. The method of knowing the goodness is by sowing a certain number of the seeds, and seeing how many plants are produced by them. If it is above two years old, it will not grow. The external signs of the seed being good are that the husk is of a bright color rather of a purple, and the kernel plump, of a light grey or blue color. If the kernel be cut across, and appear greenish and fresh, it is a certain sign it is good. If it be of a yellowish color, and friable, and looks thin and pitted, it is a bad sign. The quantity of seed allowed to the

acre in the drill way is much less than by sowing broadcast. A bushel of seed to an acre of land is 20 seeds to each square foot of land if sown broadcast, which would be sufficient; but there must be an allowance made for casualties.

The quantity of good seed I have found by experience is for sowing broadcast, two bushels, and for drilling, one bushel. And as the saintfoin does not cover all the ground the first year, which spaces are generally occupied by weeds, to remedy this, when I have sown it broadcast, I have sown four or five pounds of clover seed with it to the acre, which has answered a very good purpose, as I have then had a crop the first year.

The saintfoin is but a slow grower at first; the second year perhaps will not exceed a clover crop, but afterwards it increases every year for six or seven years before it comes to its full perfection; and as that increases, the clover goes off, and makes room for it.

This valuable plant will keep in perfection for twenty years, if you only give it a slight top dressing with soot or ashes, once in four or five years. The first summer, nor early the next spring, it should not be fed, because it will be apt to bleed itself to death; for the sweetness of it is such, that it will entice cattle to bite into the knot in the ground and spoil it; but afterwards, when it has gathered strength, the best method will be to mow the first crop, and seed it after, which is excellent for cows and sheep.

This plant, as well as trefoil, will not thrive in a wet moist soil; and as saintfoin thrives best on high grounds, it is a great advantage in the article of making it into hay, as it has greatly more advantage of the sun, and less to fear of mischief from wet, than grass which grows in low grounds. On the high grounds, the wind will dry more in an hour than it will in meadows that lie low in a whole day; and often the crops of saintfoin make a very good hay in the same seasons in which all the grass hay is spoiled. The sun on the high grounds has also a more benign influence, and sends off the dew there two hours earlier in the morning, and holds it up as much longer in the evening; by these advantages the saintfoin has more time to dry, and is made with half the expense of common hay.

Saintfoin for hay should be cut when it is half blossomed, and managed the same as before directed for clover. If saved for seed, it must be the first cutting. You may know when it is ripe by the seeds coming out easily in your hand. Dry it in the field, and thresh it there on a cloth, as it will shed and you will lose great part of the seed if you carry it to the barn. The straw will be as good as hay for horses; and the hay, when it has been

well got in, my horses that have worked hard have been kept on it alone without any grain, have been so fond of it that they have refused beans and oats mixed with chaff in the common way for it. Sheep also will be fatted in pens in winter, with only this hay and water, better than with corn, peas, oats, and the like. In short, there is no hay that is made is equal to it, and the produce will be double that of clover. The land where it is sown should be very clean from weeds, under a fine tilth; which is best done by a turnip fallow.

Lucerne is the plant which the ancients were so fond of under the name of Medica, and in the culture of which they bestowed such great care and pains. Its leaves grow three at a joint, like those of the clover; its flowers are blue, and its pods of a screw-like shape, containing seeds like those of the red clover but longer and more kidney shaped, and the color all yellow. The stalks grow erect, and after mowing they immediately grow up again from the parts where they were cut off. The roots are longer than the saintfoin, and are not single, but some times they run perpendicularly in three or four places from the crown.

It is the only plant in the world whose hay is equal to the saintfoin for the fattening of cattle; but its virtues in that respect are very great. It is the sweetest grass in the world, but must be given to cattle with caution, and in small quantities, otherwise they will swell, and incur diseases from it.

Though the common methods of husbandry will not raise lucerne to any great advantage, yet the drilling and the horse-hoe husbandry will raise it, annually increasing in value to the owner, and make one of the most profitable articles of his business.

The soil to plant it on must be either a hot gravel, or a very rich and dry land that has not an under stratum of clay, and is not too near springs of water. The natural poorness of gravel or sand may be made up by dung, and the benefit of the hoe, and the natural richness of the other lands, being increased by hoeing and cleansing from grass, the lucerne will thrive with less heat; for what is wanted in one of those qualities must be made up in the other.

The best season for planting of it is early in the spring, the earlier the better; for then there is always moisture enough in the earth to make it grow, and not too much heat as would dry up its tender roots, and kill it after the first shootings. About a pound and a half of seed will be enough for an acre.

The planting it in autumn in some climates might do; but here the winters are too cold, which would kill great part of the tender plants, and greatly stunt and injure those it does not kill.

The number of the lucerne plants should be less than those of saintfoin to an acre, because they grow much larger in this way of management, and each occupies a greater space of ground, and produces a larger quantity of hay.

The quick growth of this plant requires that it should have large supplies of nourishment, and good room to grow in; and it is better in all things of this kind to err in setting the plants too far distant, than in setting them too near.

The most fatal diseases incident to lucerne are starving and smothering; for this reason good cultivation is necessary to it, and the often turning the earth with the hoe all about it. By this means, a plant that in the common way of sowing would not have been more than eight or nine inches high, will be four or five feet, and will spread every way so as to produce a quantity of hay, more like the cutting of a shrub than a plant.

The plants should stand at five inches distance in single rows, and the intervals between these rows must be left wide enough for the use of the hoe plough, (if managed according to the horse-hoe husbandry); but if hand hoed, one foot between the rows will do: for which I will refer you to my experiments on fallow crops, where you will find that by this method I had at the rate of four tun lucerne hay per acre. But lucerne sown in drills so near will in a few years meet in the rows, which will hinder the mould being stirred, when it will starve for want of nourishment, and thereby wear out.

Lucerne is of much quicker growth than saintfoin, or any other grass. I have cut it four times in a season, whereas the others are seldom cut above twice.

Lucerne is to be made into hay, the same as saintfoin or clover; but this must be observed, that it is always to be cut just before it comes to flower. It is a fine food, if cut for the cattle green, it is so sweet and full of nourishment but it must be kept clean from natural grass, as that soon choaks and kills it.

Of the introduction of alfalfa into the Pacific coast region we have less recorded. Naturally the people of Spanish blood, settling California from Mexico, brought their favorite farm seeds with them, seeds of their best suited farm crops; among these was alfalfa. Not much alfalfa was grown in California by the Spanish colonists, enough probably to give them credit for the introduction there, as they cer-

tainly must claim credit for its introduction into southwestern Texas and probably into New Mexico and perhaps into Arizona.

It took the keen prophetic insight of the American, however, to see in the alfalfa plant the wonderful possibilities that lay within it. Gold was discovered in California in 1847 and immediately began a great rush for that land. Many men went by the long route "around The Horn." In Chili a good land and fertile, with well developed agriculture, ships tarried often for a little time. The passengers wearied with the long sea voyage took themselves with delight to the fields. There they saw alfalfa for the first time. Some of them took seed of it with them to California. Others sent back there for seed and sowed it in California, land of promise. California proved to have suitable soil and climate, and alfalfa throve there astonishingly. Gold could not always be found with pick and shovel, it could without fail be found by alfalfa roots. For the first time in its history alfalfa became a great crop and men began to plant it largely, to talk of it and write of it.

Probably no one knows more of the early history of alfalfa in California than E. J. Wickson, Director of the California experiment station and dean of the agricultural college. My letter to him containing questions and his answers thereto is presented:

I am delighted that you will undertake to help me in my alfalfa investigations. I know of no man better fitted than you. The points I particularly wish to know are not very difficult of answer.

Question: On what date did the real introduction of alfalfa in California take place, and where was it sown?

Answer: I have record of sowing alfalfa by W. E. Cameron,

near Marysville in the Sacramento Valley in 1851, who continued until he had 270 acres in 1858.

Question: What was the source of the seed?

Answer: From Chili and the plant was called Chili clover until its Spanish name alfalfa was taken up. It was some time later when its botanical identity with lucerne was known.

Question: Were there many alfalfa fields or patches in use by the Mexicans, or earlier Californians, prior to the occupation by the United States?

Answer: I never heard of any. Introduction is believed to have been by Americans from Chili with which country there was much trade and where stops were made coming round The Horn.

Question: What is the oldest alfalfa field that you know of to-day, and about how many years?

Answer: I have no definite instance. The plant on good soil—that is free soil where no root injury comes from standing water—is counted upon for more than 20 years of profitable growth.

Question: About what percentage of carbonate of lime exists in the most productive alfalfa soils of California?

Answer: We are now growing alfalfa on nearly all productive soils, the acreage on the heavier soils, formerly held to be unsuitable, increasing every year. The average lime in California soils (average of 262 analyses) is 1.25%.

Question: What would you consider an average yearly production per acre of alfalfa hay?

Answer: Five tons.

Question: What is the maximum that you have known?

Answer: I cannot be sure but think it has gone up to 12 tons.

Question: We hear very astonishing stories of long alfalfa roots; how long a one have you actually seen measured, or had knowledge of that you considered authentic?

Answer: 24 feet but others claim up to 30 feet.

Concerning Henry Miller's alfalfa I wrote in "The Breeder's Gazette" in September of 1900 as follows:

Away back in 1850 there landed in San Francisco a lad with fifty cents in his pocket, a brave heart and a determination to work and succeed in this new world. He went to work in a butcher shop. Soon he had a small shop of his own. Then it was a large shop. Then he bought, in 1858, a little land on which to hold some cattle. In 1860 he bought land in the San Joaquin

STACKS OF ALFALFA AND RYE GRASS IN CALIFORNIA.

Valley. It was dry semi-arid land. Some of his associates wondered what he would do with it. He bought more. After a time, I think in 1872, he took out a canal to water it. In 1873 he imported some alfalfa seed from Chili. He sowed 7 acres, a large operation at that time. Gradually the holdings of land and of cattle increased. Today the firm owns about a million of acres of land, most of it in California. They have about 100,000 head of cattle. They have about 120,000 sheep. This growth all represents the profit made in growing, killing and selling cattle and sheep.

Henry Miller is one of the wonderful men of our time. He is one of the men with foresight and faith. His manager, Mr. Schmitz, of the Poso ranch at Firebaugh, has been with Mr. Miller for thirty years. He told me many incidents that showed the kind of stuff of which the man is made. Here is an instance: When the water was out Mr. Schmitz was instructed to irrigate and sow barley. The land was not prepared for irrigation. Mr. Schmitz and his Irish laborers knew little or nothing of the art. They had a tremendous time of it. Mr. Schmitz lived night and day in the fields, trying to manage the elusive water. The crop was a fair one, but netted a loss of some $2,000. Mr. Schmitz reported and asked to be allowed to resign. "What for?" asked Mr. Miller. "Well, it does not pay. I would not mind working if I could see that it was a success," he replied. "See here, Mr. Schmitz, suppose you look after the work and let me do the figuring," said Henry Miller.

When alfalfa proved the success that it did the solution of the problem was in sight. After that it became a simple matter of steadily enlarging the areas of irrigated lands, of alfalfa fields, of cattle. Today on Mr. Schmitz's division of Poso farm of 160,000 acres there are 20,000 acres of alfalfa. There are 25,000 acres of irrigated native grasses. He cuts 15,000 tons of alfalfa hay. He grows 50,000 sacks of barley and 5,000 sacks of Egyptian corn. His tenants grow some 100,000 sacks of wheat and 20,000 sacks of barley.

Poso farm carries about 25,000 head of cattle. It has about 40,000 sheep and ships about 5,000 hogs each year.

Do those figures make you dizzy? Well, I will not deal much in figures from this time on. You can get the idea that it is not merely a ranch, a farm, but almost a state, certainly a principality in itself. If there is anything like it in the world I have not heard of it. We rode up the great weir in the San Joaquin River, whence the canal starts that leads off westward and divides the watered land from the dry. A lovely river is the San Joaquin at this time of the year. Calm, neither hurrying

nor loitering, it sweeps on toward the bay, flowing under cool shadows, stretching out wide over shallower reaches, and embracing tree-embowered islands. It bears water enough to make a garden of the entire valley, could it be held back until needed. The canal is large enough for steamships at the head; it divides after a time, and divides again and again as needed, until there is a vast network of ditches, hundreds of miles, so much that Mr. Schmitz declined to even guess the total length. Italian laborers take the water from the ditches and spread it over the land. Dikes, following the contours, make it spread over all. The alfalfa fields are irrigated three times each season. There is so large an area to water that it is not practical to get over them oftener than that, yet it would doubtless be better if it could be done. And the cattle graze the alfalfa, except that one crop is taken from the field and made into hay for winter feeding.

Alfalfa grows rank over here. It is the best that I have yet seen in California. The cattle thrive on it as a matter of course. They are careful not to turn hungry cattle on alfalfa pasture. They must be first filled up with hay or grass. After once becoming accustomed to green alfalfa they are never taken away, so do not get hungry, gorge themselves and bloat. That seems the explanation of it all. They graze it with many thousands, yet lose hardly any at all. And sheep are treated the same way. I never saw such lambs as these alfalfa lambs. They are born early, in February generally, and they run on the alfalfa until they go to the butchers. Often their mothers are fat enough to go also in a short time after the lambs are taken away. The herder merely restrains them from roaming about over the fields and trampling down too much at a time. The alfalfa is not grazed short, there is no chasing the sheep away after they have eaten a little, there is no running them about to keep them from bloating; they are simply gotten used to it and left alone until they get fat. And the loss is very light indeed. Shropshire rams are mostly used. The ewe flocks are largely kept up by purchase of range ewes. The increase reaches as high as 120%. The quality of the Miller & Lux cattle is very good—much better than the average. Very many registered and more pure-bred but unregistered Short-horns are used, but the California idea prevails that a Short-horn is not good unless he is red. And, by the way, there are no Short-horns in California; there are only "Durhams." This term is also used in Utah and Nevada. At present the cattle are kept until they are three and four years old. The question of early maturity seems to have been little considered.

I saw them dipping cattle as a preventive of Texas fever. The

dipping vat is made exactly on the model of a sheep-dipping vat. It is about 75 feet long and the cattle are put through very rapidly and without loss. The lime and sulphur dip is used, to which a quantity of crude petroleum is added. This certainly destroys the ticks if any exist and for a time keeps off the flies. As to the ultimate benefit, as they are put back on supposedly infected pastures, I think it a matter of experiment. It costs about five cents to dip a steer. It makes a few orphan calves, that is the worst of the practice. About 3,000 can be dipped in a day at one of these plants. The getting of the cattle to the dipping vat is the main part of the work. As a matter of dipping, this is entirely successful. None of the loss or difficulty that the Government dipping experiments reported are encountered here. And I have no doubt that the dipping removes the ticks.

Winter feeding is carried on here in an immense way. There is quite an elaborate plan of procedure. In order to understand it you must consider two propositions: one that the hay has in it more or less of "foxtail" grass, which has on it disagreeable barbs, and that it is desired to mix with the hay a very small amount of grain. The problem is to get rid of the danger of the foxtail, and to mix four pounds of ground barley with some 30 pounds of alfalfa hay and make a ration for a steer. All the hay is cut through great Ross cutters, then it is put on the floor of the great feeding barn and wet down. This barn holds no cattle. Then the ground grain is mixed with it. It stands for about forty-eight hours, until it becomes soft and slightly fermented, then it is taken out and fed. It is in the same condition as alfalfa silage. The cattle thrive better on 34 pounds a day of this ration than on 50 pounds of uncut alfalfa fed out of doors on the ground. That is what these men believe, and who will argue against so much experience? But the amount of labor involved would stagger an ordinary mind. Imagine handling 12,000 tons of alfalfa in this way, as Mr. Schmitz must do on his own farm. The amount of grain fed in proportion to hay is very small, it would seem. Yet the hay is of prime quality; it is as rich as hay can possibly be.

The method of making hay on this ranch is interesting. It is cut and raked with ordinary tools. It is then caught up by large buck rakes on wheels that carry about 700 pounds to the stack. It is lifted by a great sling, and swung over the rick by a sort of crane. Or it is loaded on wagons and hauled farther and lifted by a Stockton fork. These forks are 5, 6 or 7 feet long; they take up enormous loads and are distinctly better than the harpoon or grapple forks used East. I mean to have one on our own ranch and one in Ohio. The ricks are not left sharp, and

in our wet Ohio climate would spoil badly. The haymakers are largely Italians; the irrigators are Italians. Spaniards do some of the work. Basques do some of it, Mexicans do a part, Portuguese do a part, Chinese do the cooking and gardening. Americans do a little of everything, and are often foremen. Mr. Schmitz speaks three or four languages, and finds them almost indispensable. Things must go wrong very often on such a vast ranch; there must be perplexities and vexations enough to vex a saint. Think then how convenient to have three or four languages in which to express your disapprobation with things in general and the case in particular!

This much for one man's fortunes as built on alfalfa roots. But other men were awakening to the value of the plant.

Soon it spread over much of California, and thence eastward into Utah where it was called lucerne and where it throve as well as it could thrive anywhere on earth. In Utah were many small farmers, careful men, keeping cows and horses and pigs with poultry and bees. To these men alfalfa was a god-send. The Mormon farmers began to cut alfalfa for seed. From Utah seed nearly the whole west has been planted. Colorado took alfalfa next; fields of good size were being sown in 1886 when first the writer traveled through that state. A little later alfalfa suddenly sprang into great prominence in Colorado. By its ability to enrich soils and make lands fit for potatoes, beets or any other thing it came into great favor. A hundred villages in Colorado are built upon the alfalfa plant. Alfalfa is more to Colorado than all her gold, all her silver, all her wheat or sugar or forests. To take away alfalfa from Colorado would destroy the very foundations of her prosperity and nothing known upon the earth

could possibly replace this rich, beautiful and wonderfully useful plant.

From Colorado alfalfa came naturally into Kansas, beginning to be an important factor there about the year 1894. At first it was grown only along the Arkansas river, and in the dryer parts of the state. Gradually it overspread nearly all of Kansas, being of most importance on the richer, dryer, sweeter soils. Nebraska followed Kansas in taking up alfalfa growing. Along the Platte River it established itself strongly and in the western part of the state, while gradually, surely its roots penetrated nearly every part of the state. East of the Missouri River alfalfa made slow progress. Iowa grew a little, Missouri on her alluvial soils along the Missouri and Mississippi rivers planted fields and gradually the growth extended. Illinois undertook alfalfa culture in 1898 or earlier, but as yet the industry there is hardly more than in its experimental stage, some men having made notable success, but many having failed. Wisconsin grows much alfalfa, having soils well drained and rich in lime. Minnesota began its culture in 1857 when Wendelin Grimm came from the little village of Kulsheim, Germany, bringing with him a little bag of alfalfa seed from his old home in the Grand Duchy of Baden. This was the "ewiger klee" or everlasting clover of Grimm, and from that day to this in Carver Co., Minnesota, alfalfa has been grown. Indiana attempted alfalfa culture and the experiment station published a bulletin charging that alfalfa was not particularly

adapted to that state. In later bulletins this mistaken idea has been corrected. Alfalfa is now grown with much profit in many parts of Indiana and only that many fields yet are waiting to be limed, drained and enriched is all that prevents Indiana growing at least a million tons each year.

Alfalfa culture in Ohio came probably with the efforts of the writer and his brothers, as detailed in the introduction to this book. Pennsylvania published a bulletin in 1904 detailing how to grow alfalfa and since then much has been done in preliminary work of experimentation and it is now known that alfalfa will grow almost anywhere in that state where the land is drained, limed and enriched. Maryland grew alfalfa during colonial times and a few farmers kept it up in a small way till this day. Today alfalfa is grown in every county of the state and with the new knowledge of the lime requirement for alfalfa, its culture is now on a sure footing and the crop is destined to be one of the most important in the state. New Jersey, once in colonial days growing it well, has suffered a relapse yet there are many men over the state succeeding with it, and when the need of lime and drainage is understood, doubtless New Jersey will also grow large areas of this beautiful forage. Director Edward B. Voorhees of the New Jersey experiment station has done notable work in teaching the essentials of alfalfa culture and especially in calling attention to the marvelous power of alfalfa to enrich land when the crops are fed and the manure applied.

AN ALFALFA HAY HARVEST IN THE CORNBELT.

In New York alfalfa has been grown continuously for over a century. The following notes on the early history of alfalfa in New York, by F. E. Dawley, are of value and interest:

From 1791 to 1800, Mr. Robert Livingstone, of Jefferson county, New York, conducted some experiments, many of which were successful, and from investigations made in the vicinity of LeRaysville, in that county, I feel certain that there are still growing wild there alfalfa plants which are descended from his original plantings. Following these experiments, the next that I am able to get any authentic record of are those made about 1812 in Onondago county by Sterling Lamson and Moses Dewitt, and in Jefferson county by Ezra L'Hommedieu. About four miles west of Cedarvale, in this county, a few scattered plants have been growing for years on a side-hill, which I believe came from the seeding made by Mr. Lamson, as I can get no record of its having been planted in that vicinity until within the past ten years, and these scattering plants have been known there for at least forty years. In a diary kept by this man in 1815, the statement is made about alfalfa, that it grew so coarse that the animals would not eat it dry and that it was very dangerous in pastures because of producing bloat. In 1851 a cask of alfalfa seed was distributed among members of the American Institute and many patches were grown in New York, New Jersey and Connecticut.

In 1865 in this section there was great interest in bee-keeping. A man by the name of Rosenkranz traveled all over the country selling rights for using the Langstroth bee hive and giving instruction in bee-keeping. He had traveled extensively on the Pacific coast and had become greatly interested in alfalfa as a bee-food. Among the bee-keepers in this section who were induced to try alfalfa were my father, Wm. Dawley, James Patterson, Charles Phillips, William A. House, who lived on the farm which I now own, and many others. In the western part of the state those who tried alfalfa were not very successful, although Mr. Phillips had a remarkably good stand at one time. I believe that all of them sowed it too thinly and that the proper bacteria were not present in sufficient quantities to make it a success. One of these experimenters sent to California for a bag of seed, which was shipped to him in the hull, being very dusty and foul. From this lot of seed, however, sent about 1870, on the farm which I now own can be traced, I think, the origin of successful alfalfa growing here.

A little later than this Dr. E. Lewis Sturtevant, who had charge of the state experiment station at Geneva and was very much interested in alfalfa growing, recommended its planting quite largely and many fields were put out. The failures in this state outnumber the successes greatly; still in the townships of Onondago, Dewitt, Geddes and Manlius, Onondago county, and Sullivan in Madison county, there are to be found many acres of very successful growth, and on high lands in these counties four-fifths of all the hay cut last year was alfalfa.

At the present writing alfalfa is being grown considerably over nearly the whole of the state of New York, but chiefly in the limestone regions of central New York, its greatest use being probably in Onondaga county. There is much limestone in New York and the farmers are generally intelligent and enterprising. It would seem that as soon as they realize that by abundant use of carbonate of lime, making their soils somewhat like those alkaline soils of Colorado and California, they can grow alfalfa as well as the West, and that alfalfa in New York is worth fully double what it is in the West, they will take the matter up in serious earnest and spread its culture fast and wide.

It is interesting to know that in old Virginia, where once George Washington and Thomas Jefferson vied with each other in growing lucerne, there are now at least two great farms growing alfalfa in hundreds if not thousands of tons as is done in the West, and perhaps more interest is shown in alfalfa culture in Virginia at this time than in any other state along the Atlantic seaboard.

Of the southern states Alabama, Mississippi, Arkansas and Louisiana are doing most with alfalfa,

Louisiana perhaps leading. Alfalfa revels in alluvial soils rich in lime. These soils are found along the deltas of the Mississippi, Arkansas and Red rivers. A great per cent of the state of Louisiana is adapted to alfalfa growing once it is drained and the soil made ready. Mississippi has alluvial "buckshot" soils along the western side and limestone black soils along the eastern side. In each of these soil types alfalfa thrives. It is a remarkable fact that lands that can be bought for $25 to $50 per acre in these states will grow four tons of alfalfa hay per acre and the hay is worth at present writing $20 per ton. Albama has similar limestone soils and is doing well with alfalfa thereon. The common upland soils of Alabama will grow alfalfa when well limed and enriched and it is thriving in many places where right preparation has been made.

With all this encouraging evidence of the spread of alfalfa culture there remains much to be done. Not one acre in a thousand is made ready for alfalfa that should be made ready. Think of Iowa with her wide fields of maize, steadily growing less and less fertile because of the drain made upon them; think of her herds of cattle, her sheep, her cows and swine all craving alfalfa to balance up a ration too exclusively corn. Think of Illinois, her high priced lands, her fields famed for riches but their fertility steadily diminishing, her need of foods rich in protein, her need of soil building. And Indiana with her poorer soils and smaller farms needs alfalfa on every farm she possesses, and Ohio needs it more with her thou-

sands of dairy farms and her sheep farms and pig breeding farms. The same is true of Pennsylvania and New York, only the need is greater, for the farther east one goes the higher priced is hay and the more wheat bran is bought to furnish protein to make milk or grow animals.

All over America just now there is a quickening of the agricultural life. Men are awakening, gaining new courage, new hope. The young have higher aspirations than ever before; farming is coming out from the ruts; it is no longer a disgrace to be a farmer. The best brains and best thought and best blood of the land are being devoted to agriculture. Alfalfa comes at opportune time. It fits in on every farm, once the soil is made right. It is a permanent thing. It is a mine of riches, a magazine of rich provender, a source of fertility wherewith to build animals and to build other soils.

Alfalfa brings hope, courage and joy. It brings beauty to field and landscape. It covers over the scars made on the face of Nature, it stops the waste of erosion and soil leaching. Where it comes boys cease leaving the farm, bees come, and birds; the cows stand tranquil with full udders, land values advance, paint comes to the country school-house and happy children trudge along the lanes with well-filled dinner pails.

And is it practical to grow alfalfa over all this region? It is practical. Alfalfa is one of the simplest and easiest things grown in the world. It is one of the hardiest plants known, one of the most

responsive. It is absolutely easy to grow alfalfa. There are no longer any mysteries about it. To teach the way so plain that anyone can follow and no one longer will fail is the purpose of this book.

The writer is very earnest in this purpose. He repeats absolutely it is true that every farmer may have his alfalfa field if he has soil with water level down 36″, or soil that may have the water level so lowered, and soil not entirely composed of peat. Sands, clays, alluvial soils, all alike yield to the magic of alfalfa, all alike robe themselves in living green, all alike yield rich forage and are in turn enriched themselves by the alfalfa growing upon them. There are keys to unlock the most stubborn soils.

Today we have those keys. No longer should any man fail to make alfalfa grow. The day of "experimenting" with alfalfa is over. The day of surely growing it has come. If any man will read carefully the plain directions in this book, will read and heed, he will grow alfalfa, whether he is in Maine or Massachusetts, Dakota or Dahomey.

VARIETIES OF ALFALFA.

The botanical name of alfalfa is Medicago sativa. It belongs to the class of plants called legumes. Its relatives are the clovers, the peas, beans and locust trees. There are thousands of kinds of leguminous plants in the world and most of them have some use. Some provide food for men, as the peas and beans; some provide forage for animals; all or nearly all have the power to enrich soils. There are more than 50 rather near relatives to the alfalfa plant. Some of them are annuals, some are biennials and some are perennials. Of them all only six have come into general use as forage plants, and of these only one or two have much merit. The descriptions following are from Prof. G. F. Freeman of Kansas:

Alfalfa (*Medicago sativa*, Linn) is an upright, much branched smooth or slightly pubescent perennial plant one to three feet high. The branches arise from a rather woody base which crowns a long tap-root. This root with its branches may extend three to twelve, or, in rare cases, even fifteen feet deep, rendering this species very drought-resistant on account of its being able to bring up water from the subsoil far beyond the reach of ordinary plants. The leaves are arranged alternately on the stem and are trifoliate or three-parted, each part being slightly broader above the middle and usually tapering each way, although the apex may be frequently rounded, blunt, or even slightly notched. The pea-like flowers, varying in tint from pale, almost white, to deep reddish purple, are arranged in rather elongated loose clusters borne on the ends of the many branches. The pods are spirally twisted through one to three complete curves, forming a coil one-fourth to one-fifth inch in diameter. This pod contains from one to eight seeds. The seeds are kidney-shaped, about one-eighth of an inch long and a little more than half as wide.

From an agricultural standpoint this species is by far the most important, being probably the most widely grown and most valuable forage plant in the world.

Yellow lucerne or Swedish clover (*Medicago falcata*) is a perennial plant strongly resembling alfalfa, but it differs from alfalfa in being of somewhat lower, more spreading habit and having bright yellow flowers. It is a native of northern Europe, extending into Sweden and probably far into northern Siberia. It shows greater cold resistance than the ordinary alfalfa and is less liable to winter-killing. This species is probably identical with the yellow Siberian alfalfa recently introduced by Prof. N. E. Hansen of South Dakota.

Sand lucerne (*Medicago media* Pers.). "There has been a difference of opinion among European botanists in regard to the relationship of sand lucerne to other lucernes or alfalfas, viz., *Medicago sativa* (ordinary alfalfa) and *Medicago falcata* (yellow lucerne.) Alefeld and other botanists unite common alfalfa, sand lucerne and yellow lucerne into a single species. Some botanists look upon alfalfa and yellow lucerne as distinct species and consider sand lucerne as a hybrid between them. Others regard them all as distinct species. The three forms, however, differ so widely in agricultural value and other characters that they cannot be treated together."

"The ordinary distinguishing characters between alfalfa and sand lucerne are easily recognizable when the two are grown side by side."

"The stiff habit of alfalfa differs from the more spreading habit of sand lucerne. The flowers of the former are bluish to violet purple, while those of the latter range from bluish and purple to lemon yellow, with many intermediate shades. The pods of alfalfa are coiled in about two turns, while those of sand lucerne are in about three-fourths of one coil. The seeds of the sand lucerne are lighter than those of alfalfa. Five hundred seeds of sand lucerne weigh from 0.8 to 0.9 gram, while the same number of seeds of common alfalfa weigh from 1 to 1.037 grams."

"Sand lucerne, although a perennial like alfalfa, is not so productive in lands sufficiently moist for the latter or where it is hardy."

However, in non-irrigated land in parts of Wisconsin and in Utah it is said to surpass any other variety except the Turkestan. In the moist climate of Michigan and in the irrigated land of Utah, on the other hand, it was much inferior to the ordinary sorts. Seedsmen advertise it as being hardier, more drought-resistant and better able to stand grazing than alfalfa, and say

that it will succeed on sandy soil which is too light to produce profitable crops of other forage plants.

Yellow trefoil or Hop clover (*Medicago lupulina* L.) is an annual species and may be distinguished from alfalfa by its more spreading habit, its shorter and broader tipped leaves, by its yellow flowers, and, finally, by the fact that the pods are not coiled, as with alfalfa, although coiled to make a single incomplete spiral. These pods also differ from those of alfalfa in being black when ripe. This species has some value in moist regions, but is far inferior to alfalfa.

Bur clover (*Medicago denticulata* Willd.) and Spotted Medic (*Medicago arabica* All.), like yellow trefoil, are also annual plants and have yellow flowers. They differ, however, from all of the above-mentioned species in having burry pods. Although grown in some localities, they are of little agricultural consequence.

Bur clover inoculates land for alfalfa growing or vice versa. They carry the same bacteria on their roots. Mellilotus, or sweet clover, also uses the same bacteria. This fact is useful since it often enables us to get hold of inoculated soil, or to sow one of the inferior clovers as a forerunner of alfalfa for the purpose of inoculating the soil or of enriching it and storing it with humus.

Types and Varieties.—Alfalfa is remarkably variable. One can go into a field sown all of one sort of seed and select in it a hundred plants, no two having very close likeness. Much can be done and will be done to select varieties having desirable characteristics. Already the Colorado and Kansas experiment stations are doing considerable in this line, while other stations not so well located are also at work, notably Ohio, Minnesota and North Dakota, and the Department of Agriculture at Washington.

Natural selection, or the law of the survival of the fittest, has done much to create types. For example,

alfalfa that has grown for some generations in hot Arizona becomes by elimination a type adapted to hot climates, and alfalfa grown for several generations in Montana or North Dakota becomes also by elimination, and perhaps to some extent by mutation, a strain able to endure extreme cold.

The practical lesson to be drawn from this variability of alfalfa is that it is best to choose seed coming from a region in about the same latitude as one's own farm. Alfalfa from Arizona is not hardy in Nebraska. Alfalfa from Montana would doubtless do poorly in Arizona. Alfalfa from California has not always proved hardy in the East. Alfalfa from France and Germany usually succeeds in the eastern States of America. When it fails it may be that the seed came from Algeria, up through France, and thus was in nature similar to the Arizona strain.

Commenting on varieties J. M. Westgate, agrostologist in charge of alfalfa investigation for the United States Department of Agriculture, says:

Under most conditions, especially in the alfalfa districts, ordinary alfalfa, whether from American or European grown seed, gives quite as satisfactory results as any of the special varieties. In certain sections of the country, however, special varieties of alfalfa have been found to be more valuable than the ordinary forms. Of these the Turkestan, Arabian, and Peruvian varieties have been introduced through the Office of Foreign Seed and Plant Introduction of the United States Department of Agriculture.

Turkestan alfalfa was introduced into the United States in 1898, and has since been tried in all parts of the country. It has been found to be superior to the ordinary alfalfa in only limited sections. It is decidedly inferior in the humid sections east of the Mississippi River, but has given somewhat better results than the ordinary alfalfa in the semi-arid portions of the Great Plains and in the Columbia Basin. In addition to its drought

resistance, it is also hardier than many of the commercial strains.

Hardy alfalfa.—There have appeared during the past years several strains of alfalfa which are characterized by their hardiness and general ability to withstand conditions which are rather too severe for the best productions of ordinary alfalfa. There is some variation in the characteristics of these alfalfas, which may be grouped under this general head, but they agree in showing a considerable diversity in the color of the flowers, which varies from yellow to blue, green, and various shades of violet and purple. These colors are often clouded with a smoky hue. The predominating color is the violet of the ordinary alfalfa. The most conspicuous examples of hardy alfalfa are the commercial sand lucerne and the Grimm alfalfa of Minnesota.

The sand lucerne has been grown for a number of years in this country. It has recently been found to be adapted to the colder and drier sections of the country, where it is proving the equal of any of the alfalfas under test. It seems particularly adapted to withstand the cold winters of the northern states, where ordinary alfalfa is very likely to winterkill. It is not always the heaviest yielder in sections where ordinary alfalfa succeeds, but its yields are always satisfactory, and it is especially recommended for conditions where ordinary alfalfa does not succeed by reason of high altitudes, light rainfall, or severe winters. Its chief drawback is its tendency to lodge.

The Grimm alfalfa, which has been grown for many years in Minnesota with excellent success, was brought from Wertheim, Province of Baden, Germany, in 1857, by a German farmer named Grimm. It is claimed by some that this variety has attained increased hardiness since its introduction into Minnesota.

Dry-land alfalfa is the name usually given to ordinary alfalfa seed produced for one or more generations in the semi-arid sections without irrigation. It is proving somewhat superior to ordinary alfalfa under semi-arid conditions, and as a drought-resistant alfalfa is about equal to Turkestan alfalfa and sand lucerne.

Arabian alfalfa is proving of special value in the southwestern portion of the United States, where the winters are very mild. It is characterized by its large leaflets and the hairiness of the stems and leaves, quick recovery after cutting and very rapid growth during the growing season, and also by its ability to grow at cooler temperatures than ordinary alfalfa. On the other hand, it is extremely tender to actually freezing temperatures and generally winterkills in all except the southern and southwestern

states. Its quick recovery after cutting and its longer growing season enable several more cuttings per season to be obtained than are possible for the ordinary alfalfa. Unfortunately, seed of this variety is not yet on the market.

Peruvian alfalfa is similar to Arabian alfalfa, and is likewise characterized by its long growing season and lack of hardiness. It grows taller than Arabian alfalfa, but the stems are more woody. The seed is not yet on the market in this country, as it is not grown in Peru or elsewhere in large commercial quantities.

HABIT OF GROWTH.

Alfalfa is a plant with marvelous root growth. It is not unusual to find alfalfa roots penetrating 6′. 8′, or even 12′ into the earth. Very much deeper roots than these are reported. It is even said that alfalfa roots have been found that were 30′ or more in length, and doubtless this is true in favoring soils. Alfalfa is a desert plant by nature. All desert plants root deep and root far. By aid of these deep roots desert plants tide over long drouths; if there is no moisture in the top soil there is perhaps moisture lower down. Alfalfa is a wonderful forager for moisture and for plant food. It loves deep, permeable soils. Because its roots penetrate so deeply into the earth it does not thrive when the water table of the soil is too near the surface. Permanent water ought to be down at least 36″ for alfalfa to thrive and if it is to last for many years even more depth is needed.

Alfalfa Not a Grass.—Alfalfa is in no sense a grass. It has no communistic ideas whatever. Each alfalfa plant is a vigorous, hustling, independent individual. It pushes its roots down, sometimes in one large tap root, sometimes in two or three large roots. It fills the earth with its hairy feeding roots. It makes a branching crown of many stems. The deeper the roots can penetrate the larger the crown will be. The better the soil for alfalfa the fewer

ALFALFA SIX WEEKS FROM SEED, SHOWING ROOT TUBERCLES.--
FROM LIFE BY EDNA HOPKINS.

plants will stand on the ground. One by one the weaker plants will be crowded out till at last the strongest plants will gain their normal position when there will be a plant for each square foot of surface in very deep, rich soils of the West, and these big plants with roots as large as one's ankle; or there will be four or more plants to the square foot, as in good land in Nebraska or Kansas; or there will be a plant for each 4″, as, in thinner, poorer and shallower soils in Ohio and the East. Alfalfa roots will not stand close together in any alfalfa soil, be sure of that. Nevertheless it is good to start them thick, since spare alfalfa plants are better than weeds in the field.

Roots.—Alfalfa roots are very tough, strong and hard to cut. Penetrating the soil so deeply they make drainage channels when they decay and thus make the soil more alive. They are hard to plow. Once cut off they do not sprout again, though the top part if kept in moist earth will send out new fibers and may grow. Alfalfa is not hard to destroy by plowing; once cut off and cultivated a few times it dies.

The large roots are not the ones that feed. The small fibrous root hairs penetrate each tiny crevice of the earth and absorb the soil moisture and thus drink in their food. Going to great depths they are able to bring up mineral substances that may have leached down there. They are able to find moisture when the surface soil is parched with drouth.

The Bacteria.—Alfalfa roots absorb all that is in

the soil in the way of nourishment, but what they find is not enough to satisfy the ambitions of the alfalfa plant. Therefore it calls to its aid a host of tiny slaves, the bacteria. All clovers have useful bacteria that live upon their roots and gather nitrogen from the air. Then when the bacteria die the nitrogen is taken up by the plant and made into its tissue, into its leaves, stems and seeds. These bacteria live primarily for themselves, fastening to the little root hairs. Soon these little root hairs push out tissue and enclose the bacteria in fleshy excrescences shaped like little grapes or seeds. These excrescences we call tubercles or nodules. They are as large as clover seed or larger, or smaller. They occur singly or in masses. Sometimes soils seem naturally full of these bacteria so that as soon as the alfalfa is sown they come on the roots. When this is true the alfalfa starts off with great vigor from the beginning and endures in thrift nearly always. At other times soils are found to be barren of these bacteria and no nodules form upon the roots. Then the alfalfa seems half starved, weak, yellow, sickly.

Where Bacteria Thrive.—In some soils it is impossible to establish these bacteria by artificial transplantation or otherwise. When this is true alfalfa will never thrive. It may live for a time by aid of manures and cultivation, but it is not thrifty and it finally succumbs. It cannot withstand the onslaughts of weeds without the aid of these bacteria feeding its roots. They get their nitrogen and thus much of

their growth from the air. Thus the soil must have air in it or they cannot live. Waterlogged soils are barren of useful bacteria. Thus well drained soils are best for alfalfa. The bacteria thrive in soils alkaline, not acid. They cannot well withstand acid soils. They like a great abundance of carbonate of lime in the soil. It has not been shown that there is ever too much carbonate of lime in the soil for the good of the bacteria. Of other common western alkalies there may be a superabundance sometimes of sulphate of soda and other more harmful black alkalies. The alfalfa root is the foundation of the alfalfa plant. When it is vigorous the whole plant thrives and resists disease and disaster.

Resisting Temperature Extremes.—The alfalfa plant is hardy against cold. One could almost trace alfalfa to its original home by its very habit of resisting extreme heat and at the same time freezing cold. Desert countries have often blistering days and freezing nights. Alfalfa will be green nearly all winter down next the earth, waiting its chance. As soon as there is sun and warmth of spring it begins its growth. It is hardier than common red clover and earlier to start in spring. Different strains of alfalfa have different degrees of resistance to cold. Cold affects the alfalfa differently at various stages of growth. When a warm spell in early spring pushes it up to a swift, succulent growth a hard freeze will lay it all over as though it were killed. It may indeed be seriously set back by such a freeze but usually it

straightens up again as soon as it thaws and goes on growing in a few days. No animals should ever be let tread upon it when it is frosted. Indeed it is better for the alfalfa never to be depastured.

The First Growth.—The first growth is usually strongest, perhaps because of the long rest it has had during winter, and maybe because of more abundant soil moisture in the spring. In Ohio it begins to bloom in late May or early in June. In more southern states it blooms earlier; sometimes in Louisiana it will bloom in April, or even earlier. The height of alfalfa at blooming time varies with the soil and variety. Ordinarily it is about 30 to 40″ high. In very good alfalfa soils with abundant irrigation and good suns, it may be much higher. The writer has grown it on his old Utah ranch fields so tall that only the heads of the deer were visible as they stood nearly submerged in alfalfa verdure. In some soils where roots cannot go deep it may not get higher than 24″.

Time to Cut.—When bloom begins time is near for alfalfa harvest. One cannot judge by state of bloom altogether when alfalfa should be cut, however. Perhaps in some western soils it does not matter when it is cut; no great harm results from cutting it at the wrong season. In all eastern regions, however, it is very necessary that it should be cut at the right time. Failure to know when to cut it often results in losing altogether the thrift of the next cutting, and maybe losing the alfalfa completely. One

cannot judge of when alfalfa should be cut by the appearance or non-appearance of bloom. Usually when it ought to be cut it will be in bloom. The only safe indication, however, is found in little shoots or buds that put out from the base of the stems near the earth. When these shoots put out, like little suckers, ready to make new growth, then cut the alfalfa and cut it immediately. Cutting must not be delayed else the shoots will become so high that they will be cut off with the hay. The alfalfa must not be cut before these shoots appear, because if this is done the alfalfa will not start off promptly, and when it does start will be singularly deficient in vigor and thrift. The reason is not known, but the fact is often observed that when a part of a field is mown only a few days too early and the rest of the field after the shoots have appeared there will be a difference of 100% or more in the yield of the next crop in favor of that cut at the right time.

Further, when it is cut too early it often becomes unthrifty, rusted, yellow, sickly, and weeds and grass spring up and choke it. Thousands of ruined fields all over eastern America and in England trace their injury to having been cut at the wrong time. When it is mown off too soon all seems to go wrong with it. It may be that in some way the sap sours in the roots, the bacteria die, or some poison is secreted. Some such catastrophe is needed to account for the behavior of the plants.

Cutting for Soiling Weakens.—In England the writer has frequently observed that the habit there

of cutting alfalfa green and using it to soil horses is responsible for great damage to the fields. At the end of a field where first the scythe began its work on immature alfalfa, it was so weakened that weeds and grasses came in thick and choked it out. At the other end of the field would often be good, thrifty alfalfa, because it had not been cut too soon. It is wise to cut as early as one can, and not cut before the appearance of the shoots, because thus a better quality of hay is secured.

The Next Cutting.—Alfalfa cut at the right time makes astonishing recovery. The hay raked up, the field looks brown and bare for a few hours. Then comes the first tinge of green. In a day it is plainly to be seen. In two days it is green again. In a week no one should set foot upon it, and in four or five weeks it is ready to cut again. Times vary, of course, but in Ohio if the first crop comes off about June 1, the next crop will be due about July 1 to 4. The same rule applies to the second cutting. It must not be taken away before the buds appear. The rule of waiting till new shoots appear on the bases of the stems applies to each cutting. As the summer gets older and dryer longer times elapses between the various cuttings. The second cutting will take about 40 to 45 days to mature, and the third cutting about the same time. At no time can one disregard the rule as to cutting when the shoots have appeared. Never cut alfalfa before these shoots come. Never delay cutting many days after they appear.

Cutting Promotes Thrift.—It is a curious fact that alfalfa needs to be cut in order to keep in thrift. This is especially true in the region east of the Missouri River. Doubtless it is in part an acquired habit, speaking strikingly of the length of years that our alfalfa has been sown and mown by man. In Ohio, for example, one will sometimes put down a fence through a young alfalfa field. Afterward he cannot mow quite close to the fence and there will be corners where the alfalfa remains uncut. It is then a continual object lesson of the effect of neglect, since the uncut alfalfa becomes unthrifty, a prey to leaf fungus and other diseases. As the season goes on the cut alfalfa retains its thrift and vigor; the neglected gets more and more unthrifty. At last weeds and grass overpower it and in a few years nearly every plant has disappeared, while the plants regularly cut alongside have quite retained their pristine vigor.

Late Mowing Harmful.—In warm countries alfalfa is always green and growing, so there is moisture enough, yet it has its periods of partial rest and its times of greatest vigor. In the arid and irrigated west it seems to do no injury to the alfalfa to mow it down late in the season, or to pasture it close in the fall. In the eastern states, on the other hand, it is distinctly hurtful to alfalfa to cut it down so late that it will not go into winter with a good growth covering it to hold the snow and protect the crowns. Always there should be a growth of at least a foot of alfalfa when killing frost comes. This

should not be depastured; indeed, after killing frost no animal should be permitted to set foot in the alfalfa field. The difference in thrift and production between late mown alfalfa and that given fair treatment is very marked indeed. Many plants mown off in October will die altogether during the following winter. Thus when one means to plow the field, it is wise to mow it as late as convenient, since he gets quite a little hay from this fourth or fifth cutting, and at the same time weakens his alfalfa so that it plows easier. Very great injury in the humid regions has unknowingly been done the alfalfa by this very ignorance of its nature that led to its being mown late or depastured until winter.

Danger from Treading.—In dry countries it seems to do little injury to alfalfa to let animals run on it all winter, even though they tread it down into the dust. In all the region of America lying east of the Missouri River it is most harmful to alfalfa to tread upon it in winter, either by the feet of men or animals, or by wagons going over it. The line of direction of a farm wagon going across a field can often be distinctly traced next spring by the two streaks of dead alfalfa plants.

An alfalfa field should be a sacred place. Its gates should be closed and locked in September and not reopened till May at the earliest, probably not till the first day of June, though these dates will of course be dependent on the latitude, now having in mind the climate of about parallel of latitude 40.

Hardiness of the Plant.—Alfalfa then is one of

the hardiest plants in the world when exposed to certain trials and dangers. Drouths have no terrors for it. Cold has no terrors for it. Heat has no terrors for alfalfa. It dies, if it dies at all, of pneumonia brought on by wet feet in winter time, by cancer brought on by undrained soils and floods of rains in summer time; it dies from fungus troubles brought on by exposure to too much wet and by not having the fungus-affected tops cut away at proper time; or it dies because its allies, the bacteria, become diseased and forsake it. It is a Mexican, living by means of the hot peppers it consumes, the pepper to the alfalfa plant being carbonate of lime. Given these things, dry soil with air in it and alkaline with carbonate of lime, not sour; keep animals off it in cold weather, cut it three times a year, keep grasses from choking it, and alfalfa will endure in almost any land for half a century.

Ice Will Kill.—There is one thing that may happen, however, that no art of man can circumvent; that is ice in winter. There is a danger line along through Minnesota and parts of Wisconsin, probably extending through Michigan, where the warmth of spring comes before the cold of winter is out of the earth. Warm days thaw the snow, it makes a film of water over the earth; this freezes hard and the ground is locked in icy fetters. This may kill the alfalfa dead. It may not happen more than once in several years. When it has happened the only thing to be done is to grin and bear it, plow the field, plant to corn or potatoes and re-seed the next year. Or it may be at once resown the same season.

Life of a Field.—What then is the profitable duration of an alfalfa field? In California, in some of the dry valleys with loose subsoil, it may apparently endure for a century. The writer has walked over an alfalfa field in Texas that was 40 years old; in Kansas perhaps 10 years, in Nebraska maybe the same, or nearly as long; in Iowa probably four to six years. In Ohio alfalfa will endure for 10 years on the best drained land, and maybe for much longer time, yet the greatest profit is found in keeping it only while it is at its maximum efficiency, and that is about four years. Why expect or care to have it last forever? Alfalfa is one of the easiest established of clovers, nor is it costly to seed. It powerfully enriches the soil. Why then care to have it endure forever? It is wiser to use it only while in its full vigor, then as disaster overtakes it and one plant here, another there, dies out, leaving the stand thin, to plow it and re-seed after taking off a crop or two of grain or roots, or whatever is required.

In Maryland there is in Harford county a type of soil with such acid subsoil that alfalfa will not last more than a year or two in it. Yet some dairymen have learned that it pays better to grow alfalfa than any other crop, leaving it stand only one year, then plowing and at once re-seeding. The practice is to sow in August, letting the alfalfa grow uncut that fall, then harvesting a good crop in late May, another in late June, a third crop about the first of August, at once plowing and thoroughly preparing

the land and re-seeding. Liberal fertilizing is done each year and thus quite heavy crops of hay are grown, although it has been learned that the alfalfa will not go through a second winter, the roots decaying about 6″ below the surface. Doubtless the acidity of the subsoil is responsible in large measure for this result. If large amounts of lime could be applied to the surface just before plowing and thus turned under in direct contact with the sour subsoil, in time even this land could be made to carry alfalfa more than one year. It is interesting and useful, however, to know that the alfalfa pays well to be resown each year when this is necessary.

Essentials in Culture.—Alfalfa is no Laodicean. When it is healthy it is one of the happiest plants in the world, and when diseased one of the feeblest and most miserable. Fortunately making it healthy is pretty easy; it speaks in no uncertain tones and makes its wants known. The writer frequently takes a walk to the village along an old railway embankment, made in large part from limestone gravel, surfaced with that and with limestone screenings from the crusher. The clay in it is of limestone formation. It could not be said that this soil was exceptional in any way except that it is thoroughly drained, and has in it much lime. Scattered alfalfa plants grow along this embankment. For years they have grown and seeded there. They are beautifully green and vigorous plants and they never seem to get old. The writer, wandering down the railway line reflects, "Why, here these plants in themselves tell all that

one needs to know about alfalfa growing. Just give drainage enough, give air enough in the soil, give lime enough, give seed, and alfalfa is the surest plant to grow there is.'' And this is true. Only these simple things need be known: to make the land dry, to make the land sweet with lime, or a little more than sweet, fairly alkaline with lime, then to make it fertile and sow good seed with faith and inoculation.

What agricultural joys will follow such simple doings as these! What beautifying of landscapes, what riches in animal life, what wealth of farms and homes and villages! Upon such simple fundamentals do great things rest.

THE SEED-BEARING HABIT.

Alfalfa left alone will bloom and produce seed on the first crop. If no fungus troubles its leaves it will continue to grow, bloom and produce seed all summer. In Utah the writer has seen bushes of alfalfa more than 6′ high, covered nearly all over with bloom and seed. In all humid regions there will be leaf diseases that will make such condition of growth impossible.

Fertilization.—The alfalfa flower is probably incapable of self-fertilization without the aid of bees or other insects. F. Roberts and Geo. F. Freeman, of the Kansas experiment station at Manhattan, have made many experiments in alfalfa breeding. Briefly, in planting a nursery of alfalfa plants, separated from each other about 18″, very great variation was observed. One field was planted from seed gathered in Montana, the other from seed of so-called Turkestan alfalfa. The plants in each group varied remarkably in leaf and hardiness and habit of growth. In order to propagate the desirable types, study of the alfalfa flower was made, with its habit of fertilization. The following study or the alfalfa blossom is quoted from Bulletin 151 of the Kansas agricultural experiment station:

The flower of alfalfa is rather an advantageous one for hand-pollinating purposes. The two wings have projecting processes which overlap, and assist in holding down the curved, spring-like column formed by the united group of stamens which en-

close the pistil. A set of interlocking processes for the keel further assist in forming this spring-trap arrangement. When an insect of sufficient weight alights upon the keel, it depresses the latter, together with the enclosing wing petals; the trigger-like processes are pushed down past the upcurved column of the pistil and stamens, releasing them, and allowing the whole column to spring up with considerable explosive force against the erect standard. At the time of pollination the style with the stigma has grown up above the stamens, and when released the stigma precedes the stamens, striking the insect's body first, in case the latter rests upon the keel, bearing its deposit of pollen brought from another flower. The burst anthers in turn dust off a new deposit of pollen as they are driven past the insect, which is thus equipped with a fresh supply of pollen to become available for the next flower. Sometimes the shaking of the flower stems by the wind, or by the pelting of rain, many accomplish the same result. Self-fertilization may be secured also by visits of insects not yet loaded with pollen, which may, by setting off the explosive mechanism, bring about self-pollination. Since the pollen is shed before the stamen-pistil column is released, it happens that the stigma is already partly covered with pollen. Nevertheless, self-fertilization seems to occur but seldom in enclosed plants protected from insect visits.

The explosive mechanism of the alfalfa flower has long been known, having been discovered as early as 1832 by A. P. De Candolle.

In 1894, Burkill found it impossible to make seeds set in the unexploded flower, even though pollen were in contact with the stigma. He considers this fact to be due to the circumstance that the stigma does not become receptive to the pollen until its cells are injured by violent contact with some object. In proof he adduces the fact that he had caused unexploded flowers to set seed by pinching the stigma, by cutting off the tip of the keel, or by rubbing the stigma with a stiff brush. It appears, therefore, probable that insects secure the fertilization of alfalfa flowers largely by accidental injury to the stigma while endeavoring to cause the proboscis to enter; or else by exploding the flowers and causing the stigma to be dashed against the standard, the necessary amount of injury may be accomplished to enable the pollen to become effective, in which case it may either be the already present pollen of the same flower, or foreign pollen brought by the insect that is utilized.

Thus it is plain that insects play a large part in

the fertilization of alfalfa blooms. The honey bee helps, no doubt, where it is plentiful, and also many other sorts of insects help—butterflies, millers, ants and various small insects that swarm in alfalfa meadows. Whether honey bees are useful in fertilizing alfalfa blooms is at present a disputed point, many men affirming that they secured as large crops of alfalfa seed before bees were introduced into their regions as they do since. However this may be, it is certain that bees pay large profits in the western alfalfa-growing states. Alfalfa honey is of excellent quality and it is most doubtful if the bees ever gather any of it without unwittingly assisting in the fertilization of the alfalfa flower.

Where Seed is Grown.—The alfalfa plant has whims and peculiarities not well understood. Parts of California produce seed, other parts are said to make too little seed to be worth troubling with. Nevada is a good seed-producing region, perhaps because of the extreme dryness of the state. Utah produces much seed of high quality and Utah is a dry land. Colorado produces good seed, so does Montana in lesser amounts. The Dakotas produce some seed and large amounts are threshed in Nebraska and Kansas. East of the Missouri River little seed is grown; east of the Mississippi River hardly any alfalfa seed is saved. Stray plants in Ohio, on dry banks or along roadsides will load themselves with seed, while fields saved for the seed make not enough to be worth considering. Texas produces a good deal of seed. It has been found

that most seed is produced during fairly dry years. The alfalfa grown on high, dry land without irrigation seeds best. Large crops are grown by irrigation on dry lands, but the irrigation has to be very carefully done not to water the alfalfa too much. When alfalfa is growing rapidly and has abundant moisture, for some reason not well understood it does not produce seed; the blooms fall and growth continues. On the other hand, when moisture is deficient and conditions are much less favorable seed sets abundantly. It is perhaps the old trick of Dame Nature making abundant provision against the extermination of any of her children by providing bloom and fruit and seed whenever the existence of the mother is attacked.

Attempts to grow alfalfa seed in any state east of the Missouri River is apt to result in much disappointment. The humid climate, the lack perhaps of suitable insects to fertilize, and the attacks of rust that affects the leaves make it a very uncertain crop. There are times, however, during very dry seasons, when thin stands of alfalfa in the eastern states will mature profitable crops of seed.

GETTING A STAND OF ALFALFA.

When this is read it may be forgotten that the writer for many years has been a contributor to "THE BREEDER'S GAZETTE," an American agricultural newspaper. In his work for THE GAZETTE he has answered hundreds of alfalfa inquiries. Some of these have been put in such a way that they revealed an intelligent knowledge of the subject in the inquirers, but very many of these questions are maddening in the fact that they show so plainly that the seeker for information has almost no knowledge of his own soil or of any fundamental principles governing soil fertility or plant growth. For example, here is a sample question; many like it are received every season: "I wish to sow some alfalfa. My land is lightly rolling and slopes to the west. It was sown in oats in 1906, was in corn in 1907."

Simply that and nothing more! What an index of the state of agriculture in the United States in this year of grace 1909! Growing alfalfa is not a question of seed or sowing. Sow almost any sort of alfalfa seed, sow at any time of moon or in almost any sort of way and you will succeed, if—here is the fatal "if"—your soil is right. Sow with the greatest labor and pains, make incredible effort at preparation and you will fail, if your soil is wrong. Alfalfa growing is a soil question. Get the soil right and it is difficult to fail. It is easier to get a stand of alfalfa than of most common farm crops.

There is no mystery about getting a stand of alfalfa. To make that stand succeed once you get it, there's the rub, especially in the eastern states.

Drainage.—What are the requirements of the alfalfa plant as regards soil?

First, it likes soil to be dry, dry even in a wet time. That is, it ought to be a soil that will not fill up with water and remain waterlogged for many days. Alfalfa loves moisture too, but it must have moisture and air in the soil at the same time. Thus it likes well drained loams, alluvial soil along rivers or creeks (such lands are usually the best drained) or even gravelly soils, so they have also fertility. If naturally well drained lands are not on your farm then you can make the land dry with tiles. It is entirely practicable to drain land naturally wet and "crawfishy" with tiles so that it will grow alfalfa well. The writer has tested this on Woodland Farm where with his brothers he has laid many miles of tile underdrains. In truth not much of Woodland Farm would grow alfalfa before it was underdrained. Now about the heaviest and surest crops grow on land once too wet for alfalfa to grow at all.

Drainage, that is the very first essential in alfalfa culture. Let that truth sink in deep. Do not sow alfalfa on a marsh, nor on a waterlogged clay that will stand full of water half the year. An occasional submergence by the overflowing of a stream may do no harm, will do no harm if the submergence comes in cold weather, or if the water is moving. An overflow of even a week's duration, if the water is mov-

ing swiftly, will probably do no harm. Even a few hours of stagnant water lying over the land in hot weather may kill the alfalfa. Drain. Drain deep. Drain thoroughly. Alfalfa roots are living things. Alfalfa bacteria are probably destroyed by being under water for a long time.

Tiling.—In laying tiles where alfalfa may some day be sown see that they are laid as deep as the nature of the soil will permit. Soils differ much in this respect; sometimes the subsoil is so dense and impervious that water cannot well penetrate it. In such case it is useless to lay tiles deep in it. They will not drain the land any deeper if laid in the hard-pan than if laid just on its surface. Usually, however, one can lay tiles in clay loams and "joint clays" much deeper than he has been accustomed to laying them. The extra depth pays largely. Tiles draw water from a much greater distance when laid deep, and plants thrive in proportion as the permanent water table is lowered. If the water level in the soil never rises above a depth of 10′ from the surface all the better. Alfalfa roots will readily penetrate that distance. Tiles cannot be laid deeper than 4′ or 5′ with economy, owing to labor cost; if they could, and the soil were permeable enough to let them operate to their full depth, it would be all the better. On Woodland Farm the rule is to lay no tiles at a less depth than 36″ and the standard depth where soil is right and outlet can be had is 48″. In early days many drains were laid too shallow; these are often taken up and laid deeper.

Deficiency in Soil.—Curiously enough there are many well drained soils in the eastern part of the United States that are admirably adapted to being penetrated by alfalfa roots, yet on which alfalfa does not naturally grow well, if at all. Such soils often are loose, pervious, easily penetrated by roots. They may be of clayey loam order, or have sandy or gravelly nature. On them perhaps grow chestnut trees. Chestnut soils ought usually to be good alfalfa soils. Naturally they are not. By right treatment they may be made good. The clue to their reclamation is lime.

Soil a Living Thing.—A soil is a living, drinking, breathing thing. If it is truly alive it has in it much air, sufficient water, but that held in suspension as film water only in the earth, not in saturation. That is, there is a film of water about each little grain of sand, between each two grains of soil, and between the layers of water is air. The living soil has in it humus, vegetable matter, in greater or less amounts. It has in it bacteria in immense numbers. It is alive with bacteria. These bacteria are of various kinds and orders. Some are engaged in destroying humus. They break it down and from the nitrogen in the humus make soluble nitrates. These the plants can absorb through their rootlets. Some of these bacteria are able to assimilate the free nitrogen of the air and make it available for plants growing with roots in that soil. These bacteria exist in all soils probably where there is plenty of humus decaying. Other bacteria there are

that live on the roots of the clover and other leguminous plants. Alfalfa has its own special bacteria that enables it to appropriate the free nitrogen of the air. Alfalfa will not thrive, nor even live very long, without these bacteria helping it. It has become used to them, it depends upon them much as the southern people depended upon slave labor in days gone by. And alfalfa-promoting bacteria will not live in all soils. In some soils they are found in myriads after alfalfa has grown there for a little time, as its near relatives melilotus or bur clover. What sort of soils do we find these bacteria to thrive best in when nature has planted them, unhelped by man? What sort of soils are they that produce alfalfa spontaneously? Let us go afield.

Natural Seeding of Alfalfa.—The nearest to wild alfalfa that is found in America perhaps is in Montana, along the Yellowstone River. There the writer has seen fields sown to timothy grass invaded by the alfalfa plant and gradually crowded out till at last there was a fine stand of luxuriant alfalfa and that without the sowing of one alfalfa seed. Thus it happened: the canal water floated down a few seed and deposited them near the top of the grass field. They grew and established themselves as lusty alfalfa plants. After the timothy grass was mown off the alfalfa went to seed and scattered a circle of self-sown alfalfa seeds about the mother plant. Next year there were many alfalfa plants where there had been only one, and these in turn went to seed. The end was a well set alfalfa field,

with the timothy grass practically crowded out. And on one farm of 160 acres near this spot, at a place close to Billings, Mont., a farmer sold his one year's cutting of alfalfa hay, amounting to 1,000 tons. Now, what was the nature of that soil? And what of the climate?

First, the climate did not have very much to do with it. At least there are thousands of counties in the United States with as good climate for alfalfa growing as this special one, though it is true that there is plenty of sun and heat in summer, but an extraordinarily cold winter climate. Water for irrigation was in abundant supply and never fear of rain to cause blight or spoil haying. The soil, then? This is a semi-arid region and the soils have not for thousands of years been leached by excessive rains. Thus they are filled with all sorts of mineral salts. They are alkaline soils; that is, filled with salts of lime, potash, magnesia and sodium. Some of these salts are injurious to vegetation, at least when present in excess; others are favorable.

The one salt in this soil that especially favors alfalfa is carbonate of lime. This exists in great amounts in this soil, probably at least 1½% of this substance being present. One and one-half pounds of carbonate of lime to each hundred pounds of soil! How much would that mean in an acre? Taking only the top foot of soil it would amount to about 30 tons of carbonate of lime present. That lime is doing something in that soil; can we discover what?

A POLE STACKER HANDLING MONTANA ALFALFA.

CARBONATE OF LIME.

The most vital fact is one that we cannot now explain: the carbonate of lime makes the nitrifying bacteria thrive. They cannot seem to exist without it. Then it keeps the alfalfa in good health. Why should alfalfa or any other plant become sick? We think we know that plants give off certain toxic principles, poisonous to themselves. That is, the alfalfa roots exhale perhaps a poison that is injurious to itself and to other alfalfa roots. When there is much carbonate of lime in the soil this poisonous principle is in some way neutralized. Thus the alfalfa keeps in health and vigor and goes right on performing its miracles. This helps explain some things that have puzzled the wisest of us. Many men have had good, vigorous stands of alfalfa well fed with mineral fertilizers and with stable manures, and all at once with no warning whatever it would all die as though stricken with plague. This has happened repeatedly in many eastern and southern states. Never, so far as the writer has been able to learn, has it happened where the alfalfa was growing on a soil even fairly well supplied with carbonate of lime.

Carbonate of lime, we may as well fairly confess, is the very keynote of successful alfalfa culture. Drainage and carbonate of lime are the two essen-

tial things. All the rest that can be added will help; these two are indispensable.

Other Functions of Lime.—What other functions besides making the soil habitable for good and useful bacteria does the carbonate of lime have in the soil?

It seems the very foundation of fertility itself. The presence of much carbonate of lime in the soil seems necessary to the formation of black humus. In nature soils rich in lime become black loams. Some good illustrations of this truth are seen in two instances. In Mississippi and Alabama are soils based on decaying limestone, the so-called "black-prairie" soils. They are exceedingly rich, strong, productive soils, among the best in the South. They grow any sort of crops well, and especially do they grow alfalfa luxuriantly. Most soils in the south are very deficient in humus and without the dark brown color. That is because most southern soils are lime-hungry. The vegetation that has fallen upon them and been buried in them has not changed to black humus, or to very little of it. Why not? Because of the absence of sufficient carbonate of lime.

In Illinois one finds the northern end of the state. a black, rich prairie soil, very full indeed of humus. The southern end of the state, on the other hand, has a soil of light color, very deficient in humus. Think what story this tells! Glaciers ground up limestones in the northern end of the state and mixed their detritus through the soil. Below the line where the limestones reached the light colored soils begin.

The same sun shone on all of Illinois during these centuries, the same rains fell, prairie grasses grew over most of the land. Where carbonate of lime was abundant in the soil humus was created, and the land grew black and rich. Where there was deficiency in carbonate of lime fertility could not gather. It is a most significant lesson.

Carbonate of lime then conserves humus and fertility in some way. It makes a healthful home for the bacteria that help plants. What else does it do?

Stops Waste of Nitrogen.—Carbonate of lime stops waste of nitrogen. Decaying vegetation or humus in the soil creates nitric acid; this is readily soluble, and unless taken up by plants soon leaches away and is gone. Should there be a sufficient supply of carbonate of lime present, however, the tiny drop of nitric acid seeking to escape touches a particle of carbonate of lime, the two unite and form a calcium nitrate. This locks up the nitrogen and holds it in the soil. It is practically impossible to store fertility in soils deficient in carbonate of lime. Soils having a large store of carbonate of lime, on the other hand, will accumulate nitrogen, and hold it for many years, giving it up again when called upon by the plants. I have seen astonishing instances of this upon Woodland Farm. Certain fields have had on them at one day old home sites, where the first settlers built their little cabins and had their gardens and cow lots. For forty or fifty years these small settlements have been swept away, and nothing remains now to tell their location excepting the fragments of brick or

pottery turned up by the plow. Naturally the late treatment of these fields has been uniform, and as much manure has been applied to one spot as to another. When sown to alfalfa, however, a wonderful story is told, since the alfalfa plants, rooting deep, find stores of fertility in the subsoil, leached down perhaps from the old gardens or cow lots, and held from total escape by the presence in the subsoil of great amounts of limestone gravel and smaller particles. The outline of these old gardens and cow lots will be found so distinctly defined by the luxuriant alfalfa growing thereon that one can say with certainty, "Here stood the garden fence; there was the man's cow lot."

Maintenance of Fertility.—In America we have been wont to boast of the fertility of our farms. In truth, we have great stores of fertility, yet none too much, and in fact it is probable that there will not be found in America one farm in a thousand as fertile as it should be to yield a good profit. Other and older lands are more fertile than ours. The old fields of France have some of them been farmed for a thousand years, and none can say how much longer, and are producing today better than American fields; and in England the same story is often true. These fertile foreign fields are rich in carbonate of lime; and yet it is being added to and its store increased by each provident owner. No American farmer should be content with his stores of fertility as they exist today. His fields are not rich enough if he can profitably make them richer, and

indeed with nine-tenths of the farms of America the fertility is so low that any hope of profitable agriculture thereon must first be based upon a stern and inflexible determination to build the soils and make them rich. It is a great thought then that we have here, that soils filled with carbonate of lime naturally grow rich of themselves if planted with leguminous crops, or even left in a state of nature, and that upon these soils stored abundantly with lime almost any degree of fertility may be built. And what other function has lime in the soil? We need not stop here to discuss its power to floculate and render more porous the soil, its ability to bind together sands, and so on. Perhaps that power of lime has been exaggerated, but this is true, soils rich in carbonate of lime are almost universally rich also in phosphorus. This arises from two causes, one that lime carbonates usually carry a percentage of phosphorus in their own composition; the other, that they prevent the waste of phosphorus by its leaching away, or its uniting in insoluble compounds with iron or alumina.

Lime the Basis.—To put it short, you cannot build a soil rich in either nitrogen phosphorus or probably potash unless it is first rich in carbonate of lime. There is here a great field for thought. Hilgard says that no great and enduring civilization has ever been built upon an acid soil. This seems true. Babylon stood cn an alkaline plain rich in lime, Egypt's soils are reputed rich in lime, Greece was built upon marble hills, Rome upon limestone,

and the hills of Judea—where grew such grapes, such goodly grain, such grass that the land literally flowed with milk and honey; Judea where David the shepherd boy walked and tended his sheep and grew to the stature of a man; Judea, where Christ walked and lived and loved—is a land of limestone, the lime soft and honeycombed by water, constantly decaying and giving its riches to the soil. It is a curious thought, indeed, that had it not been for the limestone in the hills of Judea, perhaps the Master of mankind might have been born in another land.

Availability of Lime.—So far as the writer's researches have extended, everywhere that limestone is found alfalfa grows naturally, almost of itself. This book will be read by many men, we hope, who have not been blessed by being placed on soils rich in carbonate of lime. Let them not thereby be overmuch cast down. This is an age of machinery and of cheap transportation. Limestone exists in incalculable amounts throughout a great part of the United States, and can be burned or ground raw, and transported from the cliffs to the farms at very small cost. This will be done some day, no doubt. It is only a question of the farmers awakening to the advantages to be derived from the use of abundant carbonate of lime, and their asking for it, when manufacturers will be glad in nearly every state, as they have in Ohio, to place the stuff on the market at a reasonable rate. My good friend, Prof. A. D. Selby, of the Ohio agricultural experiment station, himself almost as great an enthusiast on lime as the

writer, once remarked that "Never yet was found an abandoned farm in America that had in its soil anything like a sufficiency of carbonate of lime."

Evidence of Lime.—It is easy to note the evidence of lime. Soils rich in it naturally cover with grass, which stops erosion, therefore the hills are smooth and rounded; roadsides are carpeted with grass as though seeded by some maker of lawns; animals stand tranquil and content in pastures filled with nutritious forage; horses grown on soils rich in lime have fine forms and much life and spirit; boys and girls have good teeth and strong bones; in fact nearly all agricultural joy centers around the abundance of carbonate of lime in the soil.

Add Limestone.—If you have not enough lime in your soil get it. It is a thing fairly permanent in itself. The rain leaches it away, the soil acids dissolve it. We do not know yet just how fast these processes accomplish their object, yet it is not probably so very rapid. When you put a ton of limestone in your soil it lasts till it has been dissolved by the rain or made inert by soil acids. If you put in enough lime your sons will have its benefits. With it you can set about soil building in good courage. With lime enough you can grow clovers, grow alfalfa, grow the best grasses. What fertility you add through stable manures will not leach away. A good German farmer in western Maryland remarked one day as he spoke of the large amounts of lime they were burning to apply to their fields: "Yes, Mr. Wing, it may be true that lime is not

manure, but it certainly makes our barn manures last two or three years longer than they do when we do not use lime.'' The truth is that the presence in their soil of abundant carbonate of lime did two useful things—it stopped the leaching away of soluble nitrates and it promoted the development in their soil of the wonderful little organisms that can fix nitrogen in the soil, even without the aid of legumes, the azotobacter. Has any farmer failed to note that grass land, when full of carbonate of lime, gets stored full of nitrogen, even without the presence of many clovers? That is the work, so scientists tell us, of these marvelous little azotobacter organisms.

Carbonate of Lime Is Neutral.—There is an old saying that has done more to harm agriculture throughout the English speaking world than any other known combination of words. It is this: ''Lime enriches the father and impoverishes the son.''

This saying leads men to believe that lime is a stimulant, something that enables plants to forage more vigorously and thus more quickly rob the soil, or else that the lime sets free plant food. There is, of course, some truth in these assumptions if applied to burned lime. Burned lime does attack humus or any vegetable or organic compound. Used in excess it may render soils temporarily barren. But carbonate of lime never injures soil in any way. It is a neutral thing; like sand it attacks nothing. Soil acids attack it; it welcomes the enemy and absorbs it into itself. Could we change that old saw to read,

"Lime enriches the father, and the want of it impoverishes the son," we would be near the truth. In England we read that while lime has been in use there for many centuries, it has largely been in neglect for the past forty years, and now there must be a decided awakening and a renewed use of it or English soils will relapse most sadly.

Forms and Kinds of Lime.—Raw limestone is a carbonate of lime. Burning it drives off the carbon and makes it a quick, or caustic, lime. After burning, when it absorbs moisture and carbonic acid gas again and becomes air-slaked lime, it has then less causticity than when it was first burned. If it is slaked with a little water, so that it falls into a dry powder, it is caustic lime. If it is slaked and ground in a factory it is called hydrated or agricultural lime. It is sometimes ground without adding water, when it is termed ground lime; or the raw limestone is ground into powder, which is called ground carbonate of lime, or ground limestone, or raw limestone.

Now, what of the virtues of these various forms of lime?

The burning drives off nearly half the weight of the natural limestone; thus the resultant product is nearly twice as strong as it was before burning. Thus if it must be shipped a long way by rail it may save so much in freight that it will be better to use the burned lime. Burning has also made it biting or caustic. A lump of this caustic lime held in the hand and moistened will eat the flesh. Caustic lime

will attack vegetable matter or humus in the soil. Applied in excess it will destroy bacterial life, so caustic lime is not so safe to use as the raw rock ground, the true carbonate of lime. On the other hand one can use less of it and get effect sooner, because of its energy. The difficulty in its use to promote alfalfa growing is that one ought to use more than lime enough to correct acidity when he is laying land down to alfalfa; he ought to correct the acidity and leave a goodly store of lime carbonate lying in the soil, so that alfalfa roots will be in actual contact as the plants grow. This one can hardly do with safety with caustic lime.

Use of Caustic Lime.—How much caustic lime can be safely used and how can it best be applied?

Soils differ in their power to absorb lime safely. Strong clays and soils full of sour humus can take most; sandy, poor soils must be limed with care if caustic lime is used. There is some danger of "lime burn," that is, of making soil temporarily barren by giving it an excess of caustic lime. The poorer the soils in humus the more danger of this. Yet I have seen alfalfa fields in Maryland where the only good alfalfa present was where the piles of lime had been slaked, and where probably the lime had been applied at the rate of ten tons to the acre or more.

How much caustic lime can we use? No one knows just at present. I saw this experiment tried in Tennessee: On Idlehour Farm, near Knoxville, Tenn., James P. McDonald had tried to grow alfalfa on Tennessee River lands. It had miserably failed.

Crab grass had choked out the feeble growth. Mr. McDonald was a stubborn man and had seen alfalfa grow in South America. He was determined to grow it on Idlehour. Suspecting that lime was the thing needed, he burned a lot of it on his own place and applied it with a manure spreader. His aim was to apply about two tons to the acre. In many parts he applied at least double that amount. Wherever the manure spreader dropped the lime the alfalfa grew luxuriantly and the crab grass, was vanquished. I could not but marvel as I drove through this wonderful alfalfa. It was the twenty-fourth day of July and the alfalfa stood above the axles of the carriage and was ready to be mown, the third crop for the season. There was hardly a bit of grass or any weeds in the alfalfa. To show that the lime had done the work, one could see where the man driving the spreader had left strips here and there without lime. In these strips was hardly any alfalfa, and it was little, feeble stuff, while just beside it, where the lime had been applied, it stood up like a wall.

Crab Grass and Lime.—It seems true that crab grass, that arch enemy of alfalfa in the south, is easily vanquished by use of a goodly amount of lime. I have enough evidence of this to believe that it may be laid down as a law that lime will cure crab grass in alfalfa. It is not probable that the lime destroys the crab grass, or is particularly injurious to it, but it so helps the alfalfa that it springs into quick growth and gets the start of the grass. Hardly

anything can stand before healthy alfalfa. Almost any weed will conquer unhealthy alfalfa. Lime is its tonic, its heal-all.

Amount of Caustic Lime.—How much caustic lime will we dare use? In an acre of soil, counting the top foot, there are roughly about 2,000 tons. The sweetening of this mass of soil cannot be accomplished by any handful of lime. One ton to the acre is one part in 2,000; two tons to the acre is one-tenth of one per cent. of lime. It would seem folly to use less than two tons to the acre of caustic lime. Double that, well distributed, would almost certainly do harm. Is there a man who has harmed his soil by putting in it four tons of caustic lime to the acre, seeing that it is well distributed, and that the land has good store of humus, and has then sown it to alfalfa?

Caustic lime must not be supposed to remain caustic for a long time after it is applied to the soil. It soon absorbs carbon again and becomes a neutral and harmless substance. This being true, why not use some form of carbonate of lime in the beginning? The only answer is that it is sometimes cheaper, because of freights or lack of machinery for grinding, to use the burned lime.

Other Forms of Lime.—Now for some other forms of lime. Air-slaked lime, as has been said, has absorbed a lot of carbon and is not nearly so biting and caustic as the fresh burned lime. It is frequently for sale at a comparatively low price, because it is a waste product about lime kilns. It is

safe to use in fairly large amounts on the land. Probably no harm would result from using as much as six tons to the acre of air slaked lime. One may burn his own lime and, putting it in piles, let it air slake on his own farm if he has time to wait, or he may buy it cheap from the refuse about the kilns. Bear in mind that it has gained in weight in slaking, and is only about two-thirds as strong as the fresh burned lime.

Ground lime is fresh-burned lime ground ready for use. It is very convenient to distribute, and there may possibly be some virtue in having it slake in direct connection with the land. The only objection to its use is that manufacturers often charge pretty well for grinding it. The farmer can sometimes grind it at home, or he can buy lump lime and slake it at home at almost no cost. He can pile the lime in little piles of a bushel in a place over the field and let it slake by absorbing moisture from the soil; then when it is in powder spread it at once with the shovel. Or he can slake it to powder in a large pile and apply it with a lime distributor or by use of the manure spreader. To first lay down in the manure spreader a thin layer of chaff or manure and set the machine on the slow speed, will make it work very well. Many manure spreaders are now made with special lime distributors.

Time to Apply.—When is the right time to put on caustic lime? Not in direct connection with manure, since it will doubtless attack the manure and set free more or less nitrogen that may possibly be

wasted. Better to turn the manure under and apply the lime afterward. It can then be mixed through the soil with the disk or any sort of harrow. Lime sinks, rains dissolve it and leach it down, so usually it is best not to turn it down deep. It takes a little time for lime to neutralize soil acidity, so get it on some weeks or months ahead of the time that you wish to sow alfalfa. The time of year when it is applied is not essential. A farm is a busy place, if it is a business farm. So just get out the lime whenever you have leisure, only remembering not to put caustic lime in contact with manure if you can well avoid it.

Depth to Apply Lime.—As has been said, lime sinks, so it is usually best to put it near the surface. It ought, however, to be mixed as perfectly as possible with the soil, and is not very effective when left in lumps, since it is not then in contact with enough of the soil particles. There are soils that have such acid subsoils that they will not grow alfalfa more than a year or two before it perishes. In these soils the roots decay down about six inches below the surface. Sometimes this rotting is caused by too much water in the subsoil, but when the subsoil is dry water will not stand in post holes, and then one must conclude that it is soil acidity that is at fault, especially if he finds by the litmus paper test that the soil is really sour. I have seen such soils along the Atlantic seaboard. In the making of these soils lime was left out and other combinations of chemicals put in that form probably mineral

acids. Liming the surface makes alfalfa start off vigorously and make good growth for a year or a little longer, then it begins to decay, and will rarely live the second winter. In these soils the need is to study how best to get lime down into the subsoil, or at least down in direct contact with it. I suggest that one way to accomplish this is to apply lime very liberally to the top of the land before plowing, then to turn the land as deep as possible, turning at the same time the furrows as near as practicable squarely upside down. A better plan, but more laborious, would be to distribute the lime in the bottom of each furrow as the land was plowed, turning it under by the next following furrow. This puts the lime in direct contact with the subsoil. If a subsoil plow could now follow and open the underlying ground, which would let some of the lime drop into it, the work would be done in an ideal manner.

Value of Liming.—It may make men in California or Colorado smile to read of any such laborious way of making land ready for alfalfa in the East. They need not scorn the eastern man nor his soil or methods. He has in truth better opportunity to make profit from alfalfa growing than they with their splendid soils, rich in lime and phosphorus, and their fine, sunny skies. The eastern man has advantage of splendid markets. His alfalfa when he gets it is worth to him at least $15 per ton, and if he is a dairyman or a stockman buying wheat bran at $25 per ton he can very nearly replace a ton of purchased bran with a ton of alfalfa hay grown

near his own barn. Then eastern lands sell at comparatively low prices; all along the Atlantic seaboard land can be bought for from $40 to $75 per acre that will, with proper preparation, grow from three to seven tons of alfalfa hay a year. Some western men are seeing this and coming back to the neglected Atlantic states, and with splendid western faith and enthusiasm are building alfalfa soils there and reaping rich profits therefrom. I have in mind very many instances where liming lands has brought alfalfa after it had repeatedly failed before the lime was applied.

Effects of Lime.—When God made soils He often made them by grinding up rock masses, either by use of glacial icebergs or by the grinding action of rivers. When these rock masses were of limestone, the result was a limestone soil filled with particles great and small of ground limestone or carbonate of lime. In some soils there are enormous amounts of this material. In some very fertile soils of northern Illinois, taking the top five feet there will be found in one acre as much as 500 tons of carbonate of lime. Such soils are always rich and productive. They are always natural alfalfa soils, provided they are well drained. Along most rivers the alluviums are pretty well stored with carbonate of lime, thus one sees the river bottoms growing alfalfa well when the near lying uplands are too sour to grow it at all. It is because of the greater amount of lime in these alluvial soils, that and the better drainage and fertility all around, that mark them as alfalfa lands.

There are river soils that will not grow alfalfa, but they are soils made by the deposition of silt that came itself from land too poor in lime. Much of western Kentucky will not grow alfalfa without liming, yet along the rivers, particularly along the Mississippi River, alfalfa grows gloriously. The same is true of the land across the river in Missouri. Much Missouri land needs lime to promote alfalfa growth, but the alluvial soils near the Mississippi grow it beautifully, and alfalfa growing in southeast Missouri is assuming large proportions.

In Kentucky the writer has observed certain steep, stony hillsides growing alfalfa luxuriantly, while many level and apparently much richer soils not far away would not grow it at all. The reason was plain; the small stones were fragments of limestone, and the soil, though apparently poor, was yet rich in carbonate of lime, fairly well stored with phosphorus and potash, and the alfalfa, finding itself so healthy and vigorous, foraged for its own nitrogen.

In Washington state alfalfa grows splendidly along the eastern side and in the irrigated valleys of the middle section, because the soils there are alkaline and not sour, with abundant lime, but on the western slope of the mountains and along Puget Sound it grows hardly at all, because lime is deficient in those soils. On an island in Puget Sound the writer found very luxuriant alfalfa growing near the shore, and upon investigation found great quantities of shells buried in the soil. The Indians had

feasted on clams, it would seem, and this was the dumping ground for their shells during unnumbered years. Here then was carbonate of lime, and it was most noticeable that the soil in the interstices between the shells was dark in color and evidently contained a good deal of humus, while the soil of the interior away from the lime was raw and yellow. The lesson is plain; in order to make alfalfa grow all over western Washington it is only necessary to apply lime, and as limestone is very scant in supply the best source, perhaps, would be these very shells, which could be ground to a powder and mixed with the soil.

Lime in England.—In other lands men have long imitated Nature's way and used lime in large amounts. England is built upon chalk rock, and chalk is a soft form of carbonate of lime. For centuries farmers have dug this soft chalk and hauled it to the fields, spreading it broadcast where it soon crumbled and mixed with the soil. The writer has stood on the brinks of chalk pits in England so deep that only the tops of trees peeped above their edges and marveled as he reflected what enormous amounts of chalk had been taken from them and for what a very long time men had been doing good farming in that land. It is a curious thought, too, that the soil to which these good English farmers were applying this lime was already what we would term in America a limestone soil. It was a soil once derived from the chalk rock itself, decaying through the ages through the action of soil waters and soil

acids. Rains fall, they leach out lime, plants decay, turn sour, the acid attacks lime, thus year by year th top soil loses more and more its lime and tends to sourness. Once in Lincolnshire I walked down into a chalk pit where a laborer was loading a cart, on the farm of Henry Dudding, of Lincoln sheep and Short-horn cattle fame, and asked the laborer why he dug the chalk. "It be for the dung, sir," was the response.

"And do you put it on the land?"

"Ay, and it do make the clovers and the grass grow better, sir," was the response. This on a farm already buried in rich grass, already having enough lime in its soils so that sheep pasturing on them had bones like calves and cattle stood on legs like straight columns of a temple.

Rider Haggard in his interesting book, "Rural England," makes frequent reference to lucerne, stating usually that it is grown where the land was chalky and drouthy. On one farm he found them applying a sort of marl that they dug from the subsoil, this on the farm of Robert Stephenson of Burwell, Cambridge. I quote:

> He described to me a process which I was not fortunate enough to witness, as in these days of depression it is, I understand, but seldom practiced on account of the initial expense, although it used to be common enough—that of treating fen lands with gault. This gault, a mixture of clay and marl, is dug from the subsoil out of trenches cut ten yards apart, and spread on the surrounding surface to the quantity of about 200 tons to the acre. The land thus treated is said to double its value. The cost of the operation may be put at from $15 to $25 per acre. One application will last from 10 to 12 years, the full benefits being experienced in the second year after treatment.

Mr. Stephenson also grew lucerne, and when he wished to sow down land to grass for a permanent pasture, sowed the grass seed in the lucerne field, finding that the seed took well there (as we have all learned, oftimes to our sorrow), and that the lucerne or alfalfa furnished good pasturage till the other seeds came on.

I have mentioned these foreign uses of carbonate of lime because agriculture is so recent in America that we have not much precedent to which to refer, and agricultural practice abroad is the result of experiences of the fathers for centuries back . Whatever one finds them doing over there he may feel pretty certain has been well tried and tested. In Scotland I have seen heath land reclaimed and made into farming land. The process there was to first drain the wet, sour slopes, then lime them with about thirty tons to the acre of lime, the raw carbonate of lime being used, if I remember correctly, and after that manure was used; then clovers, turnips, oats, grass or any good thing that the climate would grow.

New Work.—It is rather a new work, this use of carbonate of lime or raw ground limestone in America. A few years ago nothing could be done except to dig marls out of the earth where they were to be found, and as these marls were nearly always under water not much of this has been done. With the increase in use of concrete construction came call for crushed limestone. Railways asked also for crushed limestone for ballast material. Crush-

ers of great size and power were installed at limestone quarries and quantities of limestone dust accumulated. Finally men began hesitatingly to use this limestone dust. The results were astonishingly good. Then quarrymen began advertising the ground limestone and selling it at a low price. The farmers took hold of it in Ohio, Illinois and some other states, and at last quarrymen began installing large crushers and grinders that took the raw rock from the quarry and reduced it to powder, making the whole output fit for farm use. This is usually put on cars in bulk and sold for from 75 cents to $1.50 per ton. The low price quoted is from a point in Illinois where the writer believes the state, with convict labor, grinds limestone for agricultural purposes.

Limestone Harmless.—This ground limestone is harmless to the soil, so one may use as much of it as he chooses. Dr. Cyril G. Hopkins of the Illinois experiment station has applied it at the rate of 100 tons to the acre with not the least sign of injury to the soil. It is pleasant stuff to work with, not acrid and biting like burned lime if it gets on your skin, nor does it get caked together if it happens to get wet. One may put it on his soil at any time that suits his convenience. He may put it on in connection with manure if he wishes and no harm will result. It cannot burn out the humus, it attacks nothing. Soil acids attack the particles of limestone and are neutralized, but the lime itself does no harm no matter how much is used. It is nature's way of

using lime in the soil. Some day, soon let us hope, there will be thousands of machines busily at work grinding up the raw limestone rocks, which fortunately are plentiful enough in America, and farmers will be busy spreading this sweetening powder broadcast over their land.

Distributing Lime.—I have found some difficulty in distributing limes. Spreaders there are, but usually they do not apply it nearly fast enough. There will be machines devised that will apply as much as one wishes, up to ten tons to the acre, no doubt. At present the manure spreader seems as satisfactory as anything available for spreading ground limestone.

Quantity of Lime.—How much should be used on an acre? It is difficult to say. The art of liming is too new in America, especially with carbonate of lime, ground limestone, to give us much data. We can only guess. The writer has known of remarkable results from use of as little as three tons per acre of ground limestone. This seems an infinitesimal amount when one considers the 2,000 tons of soil in the top foot of an acre. Take that acre apart, there are 160 square rods in it. Supposing one were asked to lime one square rod sufficiently to sweeten it well, using the inert ground limestone, how much would he naturally put in? Most sensible men would put in at least 500 pounds, supposing cost was not considered. That would make forty tons to the acre, and we cannot afford that now; there are too many acres to be limed. But we can afford 100

pounds to the square rod, and that seems little enough, and yet it means eight tons to the acre. That amount I would advise when the material can be had cheap enough to make it possible, and even more. It costs? Yes, but it pays. Take an acre of old, sour land that is not worth cultivating in its natural state and put on it eight tons of ground limestone. Put the cost at $2.50 per ton. That means an expense for liming of $20 per acre. Then that land will be fit to sow alfalfa upon, as soon as it has been drained and enriched. Mind, we do not claim that lime is a manure. The lime makes it possible to grow crops that make manure. With alfalfa growing well upon that acre it ought to yield at least four tons each year, and there is a thousand pounds of hay for each ton of raw limestone rock you have used. Cannot afford it? Can you afford not to do it?

But with much less ground limestone on some soils alfalfa has come where it had failed repeatedly before. Among a mass of similar letters I find this significant one from Iowa:

"After repeated failures with alfalfa in this county (Scott, Iowa), I have acted on your advice and applied 3,000 pounds of raw limestone dust with the seeding in August of 1907. This acre, diagonally across the three different varieties, produced a uniform luxuriant growth of alfalfa at the three cuttings, besides a growth of one foot not cut. I estimate each cutting at two tons per acre. The rest of the field showed a patchy growth ranging from two inches to 18", very unsatisfactory. I am convinced that you are right when you say that raw limestone will assure success with alfalfa."

I tried for several years to help a farmer in eastern Pennsylvania grow alfalfa, but each effort was

without success. I advised drainage, and the land was drained, but yet alfalfa refused to grow. I advised manure, and the land was made so rich that hog weeds grew as high as a man's head, and yet alfalfa refused to grow. I advised much phosphorus with no result. Different times of seeding were tried, and inoculation of the soil, and yet only failure resulted. Then I gave much belated advice to lime, and lime well, to use eight tons of ground limestone to the acre and seed in late July. The man did nearly as he was told, putting on six tons of raw lime dust to the acre, and the very next year cut six tons to the acre of alfalfa hay. His field was the marvel of all the country around, and men came to see it.

I could multiply these instances almost indefinitely.

Lime in Soils.—The reader should bear steadily in mind that the natural alfalfa growing regions of the world have in their soils now about from .5 per cent to 4 per cent of carbonate of lime. Five-tenths per cent is half of 1 per cent, or about ten tons of carbonate of lime to the acre. Four per cent. would be approximately eighty tons of carbonate of lime to the acre. These figures are for the top foot of soil only. In natural alfalfa soils the subsoil is usually richer in lime than the top soil. When a man lives away from the limestone it is his privilege to buy carbonate of lime and add it to his soil. And when he lives in a region where limestone rocks abound and the soil is yet deficient because of leaching rains

of many centuries, it is his privilege to crush and grind the rocks of his own farm and put the dust over his land.

Farm Machines for Crushing.—In this connection it may be remarked that there are now machines made that will take the raw rocks that may crop out on a man's own farm and grind them into usable dust, the machines being mounted on wheels and readily portable, so that they can be drawn from one farm to another, as need demands. Thus the farmer may have a machine come to his own farm and grind up for him a pile of limestone of as many hundred tons as he desires. It will lie in pile unharmed by weather till he is ready to put in a field.

There are many thousands of acres of land in Ohio, Tennessee, Kentucky and adjoining states that is fairly fertile, is naturally pretty well drained so that the expense of drainage will be but slight, and that only awaits the coming of lime carbonate to make it produce good alfalfa. And the beauty of it is that in Tennessee and Kentucky very often the limestone is right in the neighborhood, and sometimes right on the farm where it is needed.

Summary.—I realize that I have taken not a little time to present this matter. My apology is that the subject is fraught with such import. The wealth of our land can easily be doubled. Drainage is the first step. Use of carbonate of lime is the second step, and the third is the addition of humus to the soil, the use of phosphorus, in some instances of potash, and the sowing of alfalfa. Or, if there is

prejudice against alfalfa, then sow clover, or any other useful legume. Sure it is that once the land is dry and sweet all the other good things will naturally follow in train. Bacterial life in the soil, sweet and abundant crops will follow with better animal life, more hope in the farmer's breast, better schools and more children in them, better country roads (for there will be money to pay for them) and a higher level of life and living all around.

Fertility and Abandoned Farms.—Prof. A. D. Selby of the Ohio agricultural experiment station, in an essay read before the Columbus Horticultural Society in 1907, on the question of "Abandoned Farms," makes the following significant remarks concerning the intimate relation between soil sweetness, soil bacteria and soil life, and the continuance and progress of farm occupancy. We quote:

Vietch has made the following observations: "Broadly speaking, no more striking proof of the importance of maintaining an alkaline reaction basic condition of the soil is needed than is furnished by those soils which have become famous for their persistent fertility under exhaustive cultivation. The loess soil regur of India, Tschernoseum of Russia, chalk of England, basalt of the far northwest, prairie of the middle west, blue grass of Kentucky and Tennessee, and the limestone valleys of the east are soils which are recognized as the most fertile in their respective localities, and have maintained their pre-eminence in fertility, in some cases for thousands of years. These soils are all basic in character, alkaline in reaction. The history of liming furnishes more general evidence upon the value of an alkaline reaction of the soil as one of the chief economic factors in crop production. * * *

I believe it was Berthollet who observed that "la terre est quelque chose vivant"—"the soil is a living thing." In a much greater degree in our day than in Berthollet's day we recognize the soil as a living medium, whose biological content is now rich or now poor, here abundant and full of vigorous possibilities

or there marked by a paucity in both organisms and cultural possibilities. In whatever sense my hearers may conceive of the earth, whether here covered by a wide range of growing species of trees, shrubs, herbs and grasses, and there bedecked within the range of a single farm with a number of fields in different crops, say of potatoes, corn, oats, wheat, clover, hay and the like, in like degree do I ask them to conceive of the vastly richer coincident microscopic life present within these highly cultivated soils working ceaselessly and ever and anon multiplying in incalculable numbers, yet ever, so long as favorable cultural conditions are possible, maintaining themselves both as to the variety and number of sorts.

Granting once this conception of the soil, we can understand that it is an enclosing nidus as well as a nutrient medium which supports this life within and upon it. This nidus may be here rendered highly acid in reaction by the decomposition of vegetable tissues that are incorporated in it or there become excessively alkaline if no soil leaching may occur, as with certain alkali soils of the west. But conceive in this same connection the great difference as a result of years of culture that will come about in a soil deficient in available bases which may at all times be relied upon to correct automatically the acids produced by the fermentations and decompositions taking place in the soil, as compared with a soil at the outset very largely composed of insoluble silica or sand, and lacking in these same automatic corrections of cultural tendencies. I would here again insist that these abandoned farms as farm lands are abandoned, because they come soon to lack that biologic balance in these nidus relations and in their contained organic life as well.

May we not add that the practice of rotative farming, of which this region shows an advanced type, has its justification and its profit in the very biologic balance maintained thereby? May we not go even further and point to continuous cropping in a single species as an extreme disturbance of this balance of soil organisms at the same time that it uses up particular soil constituents? I am convinced that in both cases we may reply in the affirmative and that fuller knowledge of soil life may show most strikingly the mistake of continuous cropping just as the breeding and introduction of so many soil diseases of the special crop have so often shown its economic disaster.

What has just been stated with some fullness is not given as a proven thesis; rather as a suggestion that has for many years been driven step by step into the writer's soil conceptions in the course of somewhat extended observation and reading upon farm

and soil subjects. No pretensions are made to special qualifications in this line, but none the less the writer is firmly convinced that more than soil chemistry, as it has been applied for a century, and more than soil physics, as so ably enlarged within two decades, is needed to furnish the explanation of the vital changes of the soil and their relation to successful agriculture.

When the line between calcareous or limestone outcrop and sandstone outcrop marks as it does the line between profitable land and unprofitable land for certain crop purposes, as it seems to do in some portions of Ohio, it may not be wholly heretical to look to the calcareous compounds as offering at least a part of the explanation of the differences. When history adds the weight of evidence in the maintained fertility of particular calcareous soils the same question is again raised. And since the soil chemist and soil physicist have not marked out the differences either in kind or degree, an appeal to the soil biologist, to the soil bacteriologist should now be made. Chester of the Delaware section once made determinations of the number of bacteria in a gram of a certain Delaware soil before and at periods of a few weeks after this soil had been treated to dressings of lime of various amounts and to Thomas slag. These were all in pots in comparison with untreated soil from the same source. The acidity of the original soil was determined and the amount of correction afforded by the treatment was also determined by the same method; while the untreated soil maintained an almost uniform bacterial floral of about 520,000 bacteria per gram of soil, the soil treated to dressings of lime showeu only a partial correction of apparent acidity, but an enormous increase in the number of bacteria per gram of soil. With smaller amounts of lime, say at the rate of 1,000 pounds per acre, the number of bacteria reached 2 to 3,000,000 per gram while with 4,000 pounds of lime dressing per acre, the number of bacteria reach 5 to 8,000,000 per gram of soil. If nothing more may be said, we certainly conclude that these results are very suggestive. I wonder if we have really begun the study of the problem of applying lime to siliceous soils?

Basic Slag a Source of Lime.—There is a phosphatic fertilizer on the market in eastern states wherever convenient to ocean ports that combines very nicely available phosphorus and lime. That is the Thomas phosphate or basic slag meal. This stuff is a by-product of the steel mills of England

and Germany. Our own iron ores, being poorer in phosphorus, do not make much of this substance. It is in great use in the Old World. Germany alone uses 2,000,000 tons of it each year. Wherever tested in America it seems to give very satisfactory results. The writer tested it on Woodland Farm many years ago and never got stronger, healthier alfalfa than by its use.

Basic slag usually contains from 16 to 20 per cent. of phosphoric acid with from 36 to 50 per cent. of lime. It is said that the phosphoric acid is in a form that is nearly all available, and it cannot revert in the soil nor leach away. There is hardly a farm east of the Missouri river where more phosphorus will not yield profit. Where freights are not too high, basic slag costs no more for the available phosphoric acid than any other source of phosphorus, and thus the lime is gotten free. It is advised that from 1,200 to 1,500 pounds per acre of basic slag be applied where alfalfa is sown. The large surplus of phosphorus thus given will not leach away, but will remain to feed the plants for some years, while the lime will help sweeten the soil.

Basic slag costs too much for use at present in the cornbelt states. Where it is available is in New England, New York, and along the Atlantic seaboard. The price is about one dollar per unit of phosphoric acid; that is, slag analyzing 17 per cent. available phosphoric acid would cost the consumer about $17 per ton. At present writing the Coe-

Mortimer Co. of New York import most of the Thomas phosphate.

I have seen astonishing results from the use of this substance in England, where it is applied to meadows and pastures. In May in England one sees many manure distributers or fertilizer distributers going over the meadows and pastures. If he will take trouble to see what these machines are distributing he will find in most instances it is basic slag that is being sown over the grass, sometimes with an addition of nitrate of soda or potash. Where the basic slag is put, very marked result is seen in the clovers that spring up in the grass. Even when no clover seeds are sown at all the result is often as though it had been sown to clovers, since a rich growth of them comes up and overtops the grass. The explanation is that the clovers or their seeds were already in the soil waiting for favorable conditions. The coming of the phosphorus fed the little plants, then the lime sweetened in a degree the soil, and the plants shot up and overtopped the grass. Thus the forage was much enriched, and later when the clover leaves and roots decayed the soil was so enriched that the grass was greatly thickened and strengthened. When one is applying annual fertilization to his alfalfa meadows he may well consider the use of basic slag.

Sour Soils.—It may be asked, "How do soils become sour?" Any vegetable matter decaying in the soil will create an acid there. From sweetest apples is made the sourest vinegar. Tea leaves put in a

stone jug with water will make a sour vinegar, as the writer tested in his ranching days. Soil acids accumulate in soils that have no lime to neutralize them. Some plants grow well in sour soils, but not many useful plants. Wild things grow most in acid soils. Useful legumes grow poorly, if at all, with some exceptions. And alfalfa refuses to grow at all with the soil sour.

How is one to judge if his soil is sour? If he is experienced in soils he can tell by the character of plant growth on the land whether it is sweet or sour. Certain grasses betoken sour lands. Sorrel, or sheep sorrel (Rumex acetosellan) is pretty sure to come where there is lime deficiency, and sorrel and alfalfa do not go well together. There is a simple test that any one can make with litmus paper. This is a blue paper that can be bought of the druggist, usually in little slips, stoppered in glass bottles. One can take a slip of this paper and some of the suspected soil, having it moist, and insert half the length of the slip in the moist soil and let it remain in contact for half an hour. If there is any apparent redness in the paper be sure that there is acidity in that land. If the blue paper does not turn red the land is at least neutral. To test whether the land is actually alkaline with lime, which it ought to be to grow big alfalfa, expose a slip of the paper in quite weak vinegar only long enough to turn it red, then insert it in the soil and leave it for an hour, having the soil moist and in contact. If it then turns blue again you may be sure that you can grow it on that land.

This then is true: to get maximum crops of alfalfa, to grow it as though you were growing a weed, make your land alkaline with lime, instead of having it acid. Then get it dry, add proper amounts of fertility, and the only troubles you will have will be in caring for the crops of hay and some day in breaking your tough alfalfa sod.

Where the Lime Soils Lie.—Where probably are soils already filled sufficiently with lime, and where are they deficient from the standpoint of the alfalfa plant?

In no part of the arid and semi-arid region has there been found evidence of any need of lime in the soil. Often there will be found from 1½% to 4% of carbonate of lime in those soils. This would be equivalent to from 30 to 80 tons of this substance in the top foot of soil of each acre.

Coming eastward it is doubtful if any part of Nebraska, Kansas or the Dakotas need lime, except in their eastern portions or in especially sandy parts. It seems certain that the western portions of these states have lime enough already. Southeastern Kansas needs lime, so doubtless do parts of Oklahoma and the Indian Territory.

Texas has a great diversity of soils. Parts of Texas are tremendously supplied with carbonate of lime. There alfalfa is almost a weed, suffering only from lack of sufficient rainfall. Eastern Texas, on the other hand, needs lime very badly indeed to make alfalfa thrive. Along rivers the alluvial soils are usually well stored with lime.

Arkansas needs lime badly, except in her alluvial soils along the Mississippi River. There one sees luxuriant alfalfa grown. Some of the "buckshot" soils of Arkansas have in them a great amount of lime carbonate and are destined to be great alfalfa-producing regions. The hill soils and uplands mostly are in need of more lime. There are exceptional areas of upland that have already sufficient lime native in their soils, but these areas have not yet been accurately defined.

Missouri grows alfalfa about in proportion to her lime content. In Pemiscot county along the Mississippi River on "buckshot" soil alfalfa grows gloriously. This soil contains about 1¼% of calcium carbonate. Prof. M. F. Miller, of the Missouri College of Agriculture, reports that where about ½ of 1% of carbonate of lime is in Missouri soils and humus is supplied through use of manures, alfalfa thrives.

At this time (1909) it is unknown how much of Iowa would be helped by application of more lime. A letter giving results from Scott County is presented on a preceding page. It is probable that over much of the prairie section of the state a light application, say one ton to three tons per acre of ground limestone, would put the right condition there for proper bacterial life in the soil. That is about all there is to it; lime enough is needed to make the earth swarm with the right sort of bacteria. Lime enough is needed to correct any toxic principle exhaled from the alfalfa roots.

All the region east of the Mississippi River will be helped by use of ground limestone, with the exception of some favored spots where glaciers have already ground the rocks to powder and mixed it through the land. Anywhere that alfalfa fails to thrive after the land has been made dry and fairly rich one may know that carbonate of lime is deficient. Especially may one be sure that all soils along the Atlantic seaboard are deficient in carbonate of lime, and by supplying this lack their capacity for crop production may be immensely increased.

The Chemistry of Lime.—In "The Breeder's Gazette" of July 14, 1909, Dr. Cyril G. Hopkins, agronomist of the College of Agriculture, University of Illinois, sets forth clearly the chemistry of lime in its relation to soil improvement. I quote his statement complete:

The use of lime for soil improvement is a subject which is discussed with a great deal of misconception and confusion, due in large part to the erroneous practice of referring to lime as though it were a chemical element.

Lime is not an element and consequently is not an element of plant food. It is an alkaline substance and is known in three forms: the carbonate, the oxide and the hydroxide. The carbonate is the natural form found in rocks and soils and it consists of either calcium carbonate, magnesium carbonate or a double compound of calcium magnesium carbonate known as magnesian limestone or dolomite. When highly heated these carbonates lose their carbon dioxide as a volatile gas and the oxide or quicklime remains. This substance takes up water either from direct application or from the moisture of the atmosphere and changes into the form of hydroxide or water-slaked lime. On long exposure to the air the hydroxide will absorb carbon dioxide from the air and give off water, thus reforming the carbonate compound. Thus we may say that calcium carbonate ($CaCO_3$), calcium oxide (CaO)

and calcium hydroxide (CaO_2H_2) are ordinary forms of lime; also that magnesium carbonate ($MgCO_3$), magnesium oxide (MgO) and magnesium hydroxide (MgO_2H_2) are the corresponding magnesium compounds, more or less of which are contained in magnesian limes, of which the most common form is calcium magnesium carbonate $CaMg(CO_3)_2$. Any of these compounds may be used for neutralizing acids and thus for correcting the acidity of the soil.

If it can be kept clearly in mind that these are the substances properly called lime, and that nothing else is lime, much confusion can be avoided. However, a compound properly named calcium chloride ($CaCl_2$) is often called chloride of lime and yet it contains no lime whatever and does not possess the property of lime. In other words, it is not an alkaline substance and has no power to correct the acidity of the soil. It does contain the element calcium which is also contained in the ordinary forms of lime, but the element calcium is not lime.

Now let us turn to the subject of plant food. There are 10 essential elements of plant food and it is true that calcium is one of these elements and that it is required to a greater or less extent by all agricultural plants, but it is not at all essential that calcium as an element of plant food be applied to the soil in any form of lime. It may be applied as calcium sulphate or as calcium phosphate, and it even exists in many soils which are absolutely devoid of lime which are even strongly acid and markedly in need of lime, but which, nevertheless, may contain abundance of calcium for plant food in the form of acid calcium silicates. Thus the acid soils of Illinois which require an application of several tons of ground limestone to correct their acidity contain several tons of the element calcium in the plowed soil of an acre. In some cases soils are found which are not only deficient in lime but also deficient in the element calcium and on such soils the application of any of the calcium limes would furnish both lime for correcting soil acidity and the element calcium for plant food.

Summary.—Alfalfa is one of the most beautiful, most valuable and most profitable crops in the world. It makes the most hay. The hay is the richest and best. It enriches the soil on which it grows. It endures for many years with one sowing. It has redeemed the arid and semi-arid west. It is coming into every state in the Union.

Many needless failures in attempts to grow alfalfa have resulted in eastern states. Alfalfa need not be a hard plant to establish. It is hardier than red clover. It withstands any drouth. It withstands cold better than any other clover. In some regions alfalfa seems native to the soil. In other regions all the nursing in the world fails to establish it. Why is this difference?

All natural alfalfa countries have the soil filled with carbonate of lime. There may also be other alkalies in it, and sometimes injurious alkalies, but carbonate of lime is the useful thing found. Wherever the soil is well stored with carbonate of lime alfalfa grows like a weed, if other conditions are good. Where the soil is acid no amount of manure will keep alfalfa alive very long.

Carbonate of lime is the sort that God put in the soil when He made it. Burned lime is man's attempt at improvement. Burned lime may help and may harm. Carbonate of lime, that is, raw ground limestone, never harms soil. It cannot harm soil, use it as freely as you like. One could put on 50 tons to the acre and do the soil no injury. It would merely lie in the soil inert till it was required. Carbonate of lime is needed to make the bacteria of alfalfa thrive. It is needed to free the soil from poisons that destroy both bacteria and alfalfa. Carbonate of lime stops waste of fertility, makes vegetable matter into humus, arrests fleeing nitrogen.

Ground limestone will make alfalfa grow without fail, if a few other easily met conditions are com-

plied with. The amount needed will vary; all soils have already some lime in them. Where there is marked deficiency apply 100 pounds of ground limestone to the square rod for alfalfa growing. Always leave a strip unlimed to note the result.

Here are the few simple rules needed to assure alfalfa:

First, water let out of the soil and air let in by drains.

Second, soil made alkaline, not neutral, with ground limestone.

Third, soil with some humus in it, preferably from stable manure.

Fourth, soil with phosphorus and a little potash, the phosphorus preferably from bone meal or basic slag, though acid phosphate will answer. And use enough of it. Alfalfa feeds heavily on phosphorus.

Fifth, good seed mixed with some soil from a good alfalfa field or from a sweet clover patch, sown on a deeply plowed, firm, fine seed bed, any time between April and September.

Ground limestone insures vigorous alfalfa. Vigorous alfalfa is the most energetic soil enricher in the world. When it has stood a few years if it is then plowed and planted to corn the result is simply marvelous.

A field well set in productive alfalfa will yield 5 tons to the acre. This is easily worth $10 to $15 per ton, as alfalfa hay is nearly of the same value as a feed as wheat bran. Thus you note that it yields good interest on a valuation of $250 per acre.

Common farm lands do not pay well. Invest in limestone, manure, phosphorus, alfalfa seed, make over that $75 land into $250 land and farming will pay you.

Visiting a Stone Quarry.—A visit to a limestone quarry is an interesting thing. These thoughts came one day to the writer as he strolled with a company of Ohio State University agricultural students beside the quarries at Columbus, Ohio. A great mass of limestone rock rises to within a few feet of the surface of the soil. Here the Scioto river, cutting its way through, has eroded a channel, exposing cliffs of limestone; here have come quarrymen seeking to mine the rock for building, for road ballast and for grinding to put upon the soil.

Upon this scene burst a class of students, eager and curious to note everything, like happy children out of school, climbing over the heaps of debris, shouting merry jests and making exclamations of surprise as they note the many curious revelations.

Here, by the railroad embankment, newly made, spring up blue grass and white clovers, their roots in the crumbling limestone of the ballast, eloquently telling how waste soils may be restored and covered over with vegetation where lime is. To our left a tangled jungle of old dry weed stalks standing upon heaps of limestone debris, and as we plunge within this jungle we find the weeds are mostly sweet clover, growing huge and lusty, laden last summer with flower and yet bearing seeds. Think of the

myriads of bacteria on the roots of this sweet clover, busily soil building, getting this waste land ready for more useful things.

Now we stand at the brink of the quarry, a great hole in the ground. Our gray haired teacher asks us if we know what is the most durable of all man's work upon earth, and smilingly he tells us that the most permanent thing that man has ever yet achieved is a hole in the ground. But, think of the human energy required to quarry and cart away these millions of tons of limestone that once filled this excavation; and think further than that, to the time when this part of the earth was a shallow sea where warm waves rocked endlessly and little shell-fish swam and crawled, and dying one by one, bequeathed their bones to make the limestone that was one day to become this rock; and next, the quarry-men, short, thick, brown men, hugely muscled, pounding away upon the rocks as though they loved it. They too tell the story of lime, for is not the island of Sicily one limestone rock? Yes, and these sturdy peasants tell another story, the story of the vigor that may come from simple living. For centuries their food has been macaroni and olive oil, with, let us hope, an orange for dessert, and yet today they can in physical energy far surpass the meat-eating American. And what are they doing, these swarthy Italians, with dynamite mightily shattering this rock, with steam locomotives dragging it to the crushers, and there dumping it into yawning jaws that mightily bite and chew it until it is shaped

for railway ballast or for concrete construction? And here is another machine, more interesting yet, a machine of prophecy, a machine meaning great things to the farmer, for in this machine, so small and apparently insignificant, the rock is ground rapidly into powder and this powder through endless carriers is loaded into cars, no man's hands touching it after it is first dumped, and from this mill it goes forth by cars to the fields of Ohio. Think what this means; somewhere an old sour clay field refusing to grow clover, refusing to grow anything rich enough to yield profit, sending no boys to college, giving little hope to the owner, and now under one shower of this ground limestone will come the miracle. The sourness will disappear, clover will grow, the bees will hum, the mower will click, the boy will whistle, books will come into the home and magazines, and let us hope some lad from that farm will start to the university.

Building Soils to Stay Built.—My father was a firm believer in the idea that a soil could be so enriched that it would afterward stay rich, that it would gain momentum enough, so to speak, so it would keep on caring for itself afterward. Therefore he would apply manure in large amounts to one spot of land after another, seeking to establish this condition of things.

There is much basic truth in his theory and his practice was not far wrong. When much manure is worked into sweet soil, a soil well stored with carbonate of lime, there is set up there a laboratory

where fertility is steadily manufactured. There will be air in such a soil and bacteria in enormous abundance, among them the useful bacteria that live upon any sort of decaying humus in the soil and gather nitrogen from the air, the new-found azobacter. Thus there is a perpetual fertility-gathering plant established right in the soil.

It all depends, after all, on the possession by the soil of a large amount of carbonate of lime. If that is absent the fertility put there in excess of the needs of the plants soon leaches away and is gone. The writer has traveled in lands very deficient in lime, so deficient that the well water was almost as pure as distilled water, and there has noted that not only were the fields incredibly poor, but even such places as barn lots had in them very little richness indeed, though manure had been wasted therein for a century or more.

Think how old the world is! And since the rocks cooled and vegetation started to cover the earth roots have been decaying in the soil and leaves falling thereon with stems and branches and all manner of debris. Enough vegetable matter, enough humus-forming material, has fallen to the earth and become buried in the earth nearly everywhere, to make the soil incredibly rich. Instead we commonly find even wild soils rather poor. Why? Because of the lack of carbonate of lime. That is the one thing that can fix fertility and hold it for use in future years.

On the old farm at Arlington, near Washington, it

is said that manure enough has been applied since it has been in possession of the United States to cover the soil with a layer several feet deep, and yet the land is of only very moderate fertility. Why? Because it is so lacking in carbonate of lime.

Coming back to my father's idea that land could be given such an impetus towards fertility and productiveness that it would "keep a-going" it should be said that it is only a partial truth, after all. Doubtless the nitrogen content of the soil can be maintained. In order to do this leguminous crops should come with somewhat frequent recurrence, since legumes restore nitrogen faster than anything else we know. And alfalfa is the most vigorous nitrogen gatherer at our command. No one can store a soil with fertility and draw upon it with maize or oats or wheat or timothy grass without rapidly depleting his store. All these things are soil robbers; they do not create or secrete fertility for the soil.

Phosphorus Needed.—Nor can legumes or alfalfa do impossibilities. The mineral elements are present in fixed amounts. Of potash one may have a great abundance and on many soils need never worry nor concern himself, but phosphorus is usually a thing needed and not in sufficient supply. It must be remembered that plants cannot build their tissues, form their blooms and mature their seeds without using in regular "balanced ration" all the elements of plant food. They cannot make use of an excess of nitrogen profitably when phosphorus is in scant

supply. Thus on Woodland Farm, which is rapidly becoming fertile—nearly as fertile, probably, as it is profitable to make farm land—we find it wise each year to purchase this one element, phosphorus. We put it on when we start alfalfa. We put it on the old alfalfa meadows. It pays largely in increased yield and in increased vigor of the plants. This makes the alfalfa able to resist weeds and rust and all the enemies of it. And once on the farm much of the phosphorus is retained, is used over and over again. When we cut the hay we take up phosphorus, and if we were to sell the hay this would be drained away and lost, but when we feed the hay on the farm, as we try to do with most of our crop, we sell away only as much phosphorus as is contained in the wool and mutton of the lambs and in their bones, and what goes to the manure is pretty carefully saved and put back on the land. Thus our store increases steadily.

MANURES AND HUMUS IN SOIL.

I have dwelt so long on the subject of carbonate of lime that I must now take occasion to emphasize that lime is not sufficient plant food. Lime promotes bacterial life and saves plant food and makes it available and helps it accumulate. After one has his soil well filled with carbonate of lime, then he is ready to begin to build it. If nature had filled that soil with carbonate of lime ages ago she would have gone on with the work and stored it with vegetable matter, humus. Then there would be now in that soil nitrogen and bacteria in abundance, and probably abundant phosphorus and potash as well, since phosphorus is nearly always in pretty good supply where carbonate of lime is plentiful in the soil.

Let us get clearly in mind here that liming is only a step in the soil-building process; it is the foundation of things, as it were. And now again let us repeat that soils are living things. The productiveness of the soil is dependent upon the numbers of bacteria found therein. Bacterial life is not abundant in soils that are deficient in humus, vegetable matter.

Stable Manure Best Source.—The very best source of humus is stable manure. If the reader has followed the story of Woodland Farm, related in the beginning of this book, he will have in mind the great part that manure played in building the alfalfa

fields. Early in our experience we learned that wherever we applied a good coat of manure, there we got luxuriant alfalfa. This led us to feed lambs and cattle and to save the manure with care. Later study of the use of manure showed us that there was great waste when manure was let stand in the yard till fall before it was hauled out. Therefore we made practice of drawing it at once to the fields and spreading it nearly as fast as it was made. This practice we yet observe.

Manure in the soil does very much more than add fertility. Probably we do not know nearly all that it does. First, doubtless it directly feeds the soil. There is nitrogen in manure, some small amount of potash, and a little more phosphorus, though not nearly so much phosphorus as there should be to make a balanced ration for plants. But manure brings in myriads of bacteria. These bacteria aid plant life and plant growth. Where manure is the special nitrifying bacteria abound. The bacteria too that attach themselves to alfalfa roots and clover abound much more in soils filled with manure.

Manure Brings Inoculation.—It is seldom if ever necessary to inoculate land for alfalfa when it has been well enriched with manure. I once saw a field sown to alfalfa in Canada that was so well inoculated that in six weeks after the alfalfa was sown the tiny nodules were found on the roots, and this field was the first sown in that neighborhood, nor was it artificially inoculated. It had simply been well manured. In other states I have seen the same

curious result. In Iowa on the experiment station farm at Ames a field was sown in alfalfa. All the seed was sown the same day and in no way was the treatment of one part of the field different from the treatment of any other part, yet there was secured a fine stand of thrifty alfalfa on one side of the field and very thin and poor alfalfa on the other side. The explanation seemed to be that on a previous year one side of this field had been manured and sugar beets grown thereon. Yet all the field seemed very fertile and Director C. F. Curtiss thought that planted in corn all of the field was rich enough to grow 80 bushels to the acre. But that addition of some stable manure a year or two previously made one side of the field eminently fit for alfalfa, while the other side remained in unprofitable condition so far as alfalfa was concerned. From experience I feel sure that I had rather take a rather poor piece of land, well manured, for alfalfa growing, than a naturally rich piece of land with no manure. In truth some of the heaviest alfalfa I have ever seen grew on Woodland Farm on soil naturally very infertile, though well filled with lime, after the field had been well coated with manure, the manure turned under deep and alfalfa sown.

One day I was plowing in this self same field when a curious thought came. A flock of black birds was following the plow, hopping eagerly along and keeping up animated discourse, meanwhile busily searching for something. What they were after, of course, was earth worms. The thought then came,

"Why, here is the best indication yet of whether alfalfa will thrive in a field. If the black birds follow the plowman it is sure to grow; if no black birds come let him beware how he sows alfalfa." It is indeed a true indication for all eastern soils; there may be lands in the South and West where the earth worm is not a sure indication. Earth worms thrive only where there is humus in the land. They do a most useful work in opening the soil by means of their tunnels to let in air and let out water. They bury up vegetable matter and promote bacterial life. Where earth worms are the soil is evidently drained, although it may not be drained deep enough.

Alfalfa Loves Rich Soils.—The plain truth is that thousands of men all over the eastern states of America have tried to grow alfalfa on land too poor for it. Alfalfa loves fertile soil. In turn it adds greatly to the fertility of any land on which it grows. It is an energetic soil enricher, but it will not enrich poor soils. That may be a pity, but it is after all in the order of Nature. "To him who hath shall be given." One must have fertility in order to trap more fertility. No other available plant will gather so much fertility as the alfalfa plant. A field of it will gather nitrogen largely, the hay may be fed, the manure saved, another field enriched and sown to alfalfa and thus the fertility will spread from the one spot of infection till all the farm is covered. But only by beginning right, by making one field rich and dry and sweet, getting it set in alfalfa,

then from the manure of that field spreading to another, can a man succeed. It is easy once you get started. The farther you go the faster the work proceeds. I write now of rather poor eastern soils. Of course there are soils already so rich in all needed elements of plant food that it is idle to add more. Men owning such soils are more blessed than they probably realize.

Soils Devoid of Humus.—Will not alfalfa grow in soils devoid of humus? It is an interesting question. I feel that it will, under certain conditions. There are desert soils that would seem to be almost devoid of vegetable matter, yet fully charged with mineral salts and in these I have seen the most tremendous alfalfa that I have ever seen. Perhaps there was more humus in that gray-colored lime-impregnated alkaline soil than I thought, but it certainly was as hard as brick when dry and of the color of lime mortar. It is sure, however, that in eastern soils humus is most desirable; how indispensable it is remains to be worked out.

An Example of Farm Practice.—On Woodland Farm there is one 60-acre field commonly called the Gill field. It has not long been a part of the farm. The soil was clay, some of it white and some of it black. A part of the field was low and peaty. For many years it had probably not paid the cost of cultivation. It had had little or no manure since the forest was cleared away.

The first step was to get rid of surplus water and miles of ditches were laid, one of them to give out-

let being for some distance 10 to 12 feet deep. The usual depth was 3 to 4 feet. Then a very little stable manure was spread over the field and red clover was sown with beardless spring barley as a nurse crop. With the clover was sown a fertilizer composed of tankage and acid phosphate. The barley was cut off for hay and the clover came on and made a fair growth. It was a good stand and had a healthy look, which no one remembered seeing on this field for many years. The clover was cut for hay and seed, and a trifle more of manure spread over the ground. It is evident that on a 60 acre field one will not strew manure very thickly unless he has access to a very large store, and only the farm barns and feeding yards could be drawn upon.

The land was then plowed and planted to corn, making about 55 bushels per acre. Its previous crop had been about 20 bushels. On the corn stubble more manure was spread in 1904 and again the land was sown to clover with a nurse crop of beardless spring barley. This time it was hoped that the field might be dry enough and fertile enough to take alfalfa, so a mixture of alfalfa was put with the clover, about 10 per cent or a little more. Again the barley was made into hay.

This time the clover was a glorious success, yielding more than double what it had yielded the first year and the alfalfa came in strong for the second cutting. It was vigorous over nearly all the field. In the spring of 1906 the field was again sprinkled somewhat with manure and plowed for corn. The

yield that year was about 90 bushels. Again with a light coating of manure it was put in corn. This time the yield was 85 bushels. For the corn crop a dressing of 400 pounds per acre of raw Tennessee rock phosphate was applied. Just what effect this had we do not know, as we left no test strips. It probably was of material benefit, however.

Once more a light application of manure was made. In truth the applications of manure were all light except on certain spots of exceptionally poor white clay. The land was plowed again and seeded (in April, 1908), to alfalfa with a nurse crop, as usual, of beardless spring barley. With the seeding was sown fertilizer, plain acid phosphate, analyzing about 16 per cent available phosphoric acid, at the rate of 250 pounds per acre.

1908 proved a very dry summer yet a splendid stand resulted over the whole field. A crop of barley hay was cut and later a light crop of alfalfa hay, probably not quite one ton to the acre. From the window where I sit I look out afield across this very stretch of land. It is (May 5, 1909,) a glorious sight. Aside from a few wet pond holes there is not a square foot of the land that is not covered with green and growing alfalfa plants. That field should make near 5 tons of hay this year. And every year since the manure spreader started over the tiled fields the land has paid well.

It is not probable that alfalfa would have made a strong growth on this field without this slow bringing-up process. The land was too run down, too de-

pleted of humus. Could more manure have been spared doubtless the field could have been gotten ready for alfalfa earlier, but it was not available, so red clover, which is less exacting, came in first and paved the way.

Methods of Using Manure.—While there can be no question of the value of manure for alfalfa yet there are several ways of using it, some much more successful than others. It is seldom good practice to apply heavy coats of manure and at once sow alfalfa. The trouble is from the strong growth of weeds and annual grasses that will result and which may in part smother the alfalfa. Manure is often filled with weed seeds, has tendency to rush rapidly all weeds that naturally spring up and these worthless things outgrow the little alfalfa plants. Weeds may usually be subdued by mowing off the field two or three times during the season, but there is danger in mowing young alfalfa at the wrrong time which sometimes destroys it. Briefly, alfalfa ought not to be cut till little shoots appear on the bases of the stems. These shoots appear as buds which develop into new stems. Before these shoots appear it sometimes quite destroys alfalfa to cut it off; this is especially true the first season of its existence. So one can not mow off weeds till these little shoots come. The writer has more than once seen efforts made to force alfalfa to grow by heavy manuring when what it really needed was liming. The only result was a worse crowding by weeds.

It is very much better to apply a heavy coat of

manure and plow it under the preceding year, then plant a crop of corn and keep the crop absolutely clean of weeds and grass so that no seeds will be formed. This gives pretty clean land for alfalfa sowing the succeeding year. Impossible to keep corn land clean, say you? It is neither impossible nor very difficult. On Woodland Farm it has been found that about 5 plowings with two-horse cultivators followed with two goings through with one-horse garden cultivators of the many shoveled type, kept the corn almost absolutely clean, and men with hoes rapidly completed the work. A good stand of corn greatly helps here.

Eradicating Fox-tail Grass.—Fox-tail or pigeon grass (Chaetochloa glauca) is one of the worst enemies of alfalfa in all eastern America. It is an annual grass that becomes very thick in young meadows and sometimes in old ones. Mowing it off does not prevent its going to seed, in fact mowing it off only seems to make it grow thicker. It cannot be eradicated by disking in new alfalfa fields. Take it all in all it is the worst pest of alfalfa in the eastern states. Crab grass is next to it, but crab grass does not trouble where there is plenty of lime in the soil, while fox-tail is no respecter of lime or anything else.

Fortunately fox-tail has its weak point; its seeds do not live long in the soil but soon germinate there and grow. On Woodland Farm we have kept a corn field absolutely clean for one year, and next season sown the land to alfalfa, with the result that we did

not see a single plant of fox-tail on a square rod, and this over a great part of the field. Just destroy the plant absolutely before it seeds during one year and you have it conquered.

Growing Humus-making Crops.—Not every farmer has access to a manure heap. Some have too much land, some have too few animals. Thus many who wish to grow alfalfa desire to grow on the land some crop that will help fill the soil with needed humus. What is available for this purpose? Very much depends here upon the location.

Cowpeas.—In Tennessee, and probably in Kentucky, the cowpea is a good forerunner of alfalfa. The cowpea has several excellent qualities. If a vigorous growing variety is chosen it covers the soil all over and shades it. This shade promotes the gathering of nitrogen as we have long known. The pea vines smother weeds and so help clean the land. Their roots, abundantly supplied with nodules, gather nitrogen and store it in the soil. After cowpeas the soil is also much more friable than it was before. The vines may be left to lay upon the land, disking them and turning them under, or may be cut off for hay. Certainly one gets more humus to turn them under. In the South a crop of cowpeas may be grown and the land plowed and sown to alfalfa the same year. This is not practicable north of the Ohio River. Morgan found in Tennessee a very great increase in alfalfa yield when it was sown after cowpeas.

Turning Under Green Cowpeas.—There seems a

somewhat greater danger of souring land when green crops are turned under than when they are left to ripen and decay somewhat on the surface before being turned under. It is not easy to account for this fact. It is always well when turning under cover crops where alfalfa is to be sown to use a larger application of lime than one otherwise would use, since thus he avoids the danger of souring the land.

Cowpeas however, may do soils good and may possibly do them harm. It has been taught that cowpeas always build soil, whether the vines are taken away or left on the soil to be turned under. Prof. C. A. Mooers of the Tennessee Station has shown that cowpeas when cut and removed from the soil have a marked effect in depleting it of fertility. Probably they rob it rapidly of available phosphorus. It is plain that when cowpeas are grown to prepare the land for alfalfa seeding they ought to be turned under, not taken away from the land. "Cut them and put the manure back?" Yes, but would it come back?

The Soy Bean.—An easier crop to grow than the cowpea is the soy bean, and it also is a soil enricher and affords much humus when turned under. Soy beans are of many sorts. The large growing kinds, like the Mammoth Yellow, make the most vegetation for turning under, while smaller growing sorts make most seed in northern latitudes. Soy beans to do well need soil inoculation. It will come of itself if they are continuously grown on the same land. Soy

beans are drilled in drills about 24 inches apart and cultivated carefully till they cover the land, when their shade suppresses weeds.

To get a money crop out of soy beans and yet have a hot of humus-making material is easy. One does it with hogs, turning them in after the bean crop is mature and letting them harvest the beans. Afterward the stems remaining with many leaves will be plowed down.

Soy beans respond well to fertilization with phosphatic fertilizers. The larger grows the soil-building crop, whether of soy beans, cowpeas, crimson clover or anything else, the larger the alfalfa will grow after it. Therefore fertilizer applied to the cover crop is all to the good.

Crimson Clover (*Trifolium incarnatum*).—One of the most charmingly beautiful clovers is crimson clover, the trifolium of the English farmer. It is an annual clover. Sown in summer it makes a fall and winter growth (if there is any open weather) blooms in May, ripens its seed and dies. It is of no use sown in the spring. It is much used in England, France and the Middle Atlantic States of America. It is a good forerunner of alfalfa. This plant is remarkably cold-resistant and in suitable soils grows during every warm spell of winter. It enriches soils admirably if it has itself the right bacteria at work on its roots. On some soils where it is new it needs inoculation. Crimson clover is sown in late summer or early fall, usually as a catch crop after corn or garden truck. It makes

rapid growth during the late season and starts early in spring.

It is easily established if sown in late July or August. It will not endure heat so is of no use sown in the spring. It grows during cool weather. On the other hand it will not endure extremely cold weather, and is usually killed by repeated freezing and thawing of spring in the region of the corn-belt. It is especially at home in Maryland, Delaware, New Jersey, Virginia, and in fact all along the Atlantic seaboard. There it is an admirable catch crop and forerunner of alfalfa when one is desirous of bringing in large areas to meadow with least possible delay.

Roberts shows that the fall growth of crimson clover in New York, taken on Nov. 2, yielded as much as 155 lbs. of nitrogen per acre and doubtless the spring growth would have yielded in addition even a greater amount had not the plants killed out during the freezes of spring. Nitrogen is difficult to buy for less than 15 cents per pound and often costs much more, so it is clear that the crimson clover had done a lot of work at nitrogen-gathering very economically indeed.

Using Crimson Clover.—A good way to use crimson clover is to sow it in the corn at last working, or to disk up an oat or wheat stubble and sow it there. The latter way will give sure results. Use phosphorus in some form to stimulate the crimson clover, since the better it thrives the more it will do for you and all will be kept in the soil for the

use of the succeeding alfalfa in any case. Acid phosphate works well with crimson clover; put on 200 pounds of it per acre, choosing always a grade analyzing a good percentage of available phosphoric acid. It likes a good seed bed too. Mix with it 10 per cent of alfalfa, and if the land has never had on it either alfalfa or crimson clover, get some infected earth from an old field of each of the plants.

Infecting a Field.—One can use rather a small amount of earth and get good results in inoculating a field if he does it in the right manner. Let him get as little as 100 pounds of earth from where crimson clover has been grown and 50 pounds of earth from an alfalfa field or a sweet clover patch and mix these together and pulverize them well. Do this away from the sun. Then mix the crimson clover seed, say 15 pounds and say 2 pounds of alfalfa seed with the 150 pounds of infected soil. Sow this altogether on an acre of land. Sow it if you can late in the day, or at any event follow the sower with a harrow that will at once stir the land and cover seed and infected soil. Sunlight is fatal to inoculation.

The result will be that both sorts of plants will grow well together and the alfalfa plants, while much more feeble in growth than the crimson clover, will yet hold its own pretty bravely and will become inoculated and thus will prepare the land for a single seeding of alfalfa next year.

Crimson Clover for Pasture and Hay.—The crimson clover will make good pasture in the fall and

early spring. Do not pasture it much if you wish the full benefit of its nitrogen-gathering and humus-making. Before the seed forms, and as early as it flowers, it can be made into hay. Crimson clover hay is nutritious, only when cut too late it has a bad habit of sometimes killing animals by forming hair balls in their stomachs, so it is best to let it ripen and take off a crop of seed, putting the straw back, or else to plow it under and use all the growth as a manure. Do not expect crimson clover to do much without inoculation. This comes in more easily with crimson clover than with most other legumes.

Alfalfa Following Crimson Clover.—As soon as the crimson clover is turned under begin cultivation of the land and get it in fine tilth, destroying any weeds that may spring up. Do not sow the alfalfa seed till the soil is well stored with moisture. After every rain go over the field with some efficient sort of harrow. If the land is not hard a spike tooth drag harrow is one of the best implements of summer culture. Should rain make it hard and in danger of baking, the disk or spring tooth may be needed.

The lime may be put on now, though it would have been better to have put it on before the crimson clover was sown so that it could be doing its quiet work of sweetening the land.

As soon as the land is stored with moisture, say by the last week in July or some time in August, the alfalfa may be sown alone. One ought to ob-

serve carefully the scattered alfalfa plants that grew in the crimson clover to see if they were inoculated, so as to know whether to do anything further toward inoculation of the land before sowing to alfalfa alone.

Nodules on the Roots.— If he finds the alfalfa plants vigorous, of thrifty growth and dark green color, he may make a good guess that they are safely inoculated. If they are feeble, pale, spindling, yellow, he may well doubt the inoculation having "taken." To make sure let him very carefully dig up alfalfa plants and wash off the earth from their finer root hairs. The nodules are easily seen when present, though one can seldom get them by pulling up a plant, since they are so easily stripped off, their attachment to the roots being delicate. They are of light color, about the size of alfalfa seeds or a little smaller and are sometimes, when conditions are good and lime is plentiful in the soil, set on like bunches of grapes, though usually they are found singly on the little root hairs.

Crimson Clover in Conclusion.—Crimson clover is a plant better adapted to cool weather than to hot, to England and France, where it thrives, than to regions where grows the royal maize plant. In England it is termed trifolium and is highly esteemed for soiling in May. It thrives best in sandy soils along the Atlantic seaboard and will probably never be of much importance west of the Allegheny Mountains or north of the Ohio River. But in Virginia it is a great aid in getting alfalfa set on old fields

needing humus sadly. It has failed in countless instances because of lack of inoculation. If one wishes to grow it he should either inoculate with soil from some successful crimson clover field or should persist year after year in growing it on the same soil till at last the inoculation comes. There seems a wild clover along the Atlantic Coast that carries the same bacteria as crimson clover but this is not found west of the Alleghenies. With proper inoculation crimson clover will succeed over a far wider territory than is now known or supposed.

Melilotus or Sweet Clover.—What is a weed? A plant out of place? Weeds there are and weeds. If one must have them, and usually he will, he could hardly have a better one than Melilotus alba, or white sweet clover. There are two sorts of sweet clover, one with white blooms and one with yellow. The yellow-flowered sort is Melilotus officinalis. It is not so good as the white nor so common. Sweet clover looks like alfalfa. Indeed, it is a sort of first cousin to the alfalfa plant. The main difference is that it has a less deeply boring root stock and is a biennial, or a two-year plant, while alfalfa may live half a century. Sweet clover is a good sort of weed, because it is not unsightly and it feeds the bees and wherever it grows it mightily enriches land. It loves lime land and hard places along roadsides and on railway embankments. It will grow 6 or 8 feet high in favorable places or if it is cut down close it will bear seed when only just above the earth.

It was Dr. Cyril G. Hopkins who first called at-

tention to the fact that alfalfa and sweet clover bear the same bacteria on their rootlets and that sweet clover inoculates land for alfalfa. (Breeder's Gazette, Sept. 16, 1903.) So there is quite a useful combination of facts. Sweet clover is very hardy, it will grow on poor soil, it enriches soil very much and it improves the physical condition of soils, then it inoculates the land for alfalfa. In truth many fine fields of alfalfa have had their start from inoculation taken from sweet clover weed patches along roadsides.

Melilotus has never been treated as a farm crop in the North. In the South it is much used in Alabama and Mississippi, both as pasture and for hay. No better authority on melilotus could be found than Prof. J. F. Duggar, Director of the Alabama experiment station. I quote from a letter from him:

In reply to your request, I give you the following data on Melilotus alba (sweet clover), as it is grown in the central prairie belt of Alabama and Mississippi.

The seed should be sown in February and lightly covered. It may be sown either on ground devoted entirely to this crop or sown with seed oats or among growing plants of fall-sown oats. At least one bushel of unhulled seed per acre is needed. If sown alone and on good land there will usually be one or two cuttings the first year. If sown with oats as a nurse crop and on poor land, the first year's growth will scarcely be sufficient for cutting, but will afford a fair amount of pasturage.

The second year new shoots spring from the old crowns early in March and the first cuttings of hay can be made early in May. There is usually a second cutting. Melilotus should be cut when just beginning to bloom, since after this date it rapdly becomes woody. The hay, especially that secured the year the seed are sown, is very nutritious, the composition resembling that of alfalfa, though melilotus hay contains a smaller proportion of leaves, and the stems are coarser, especially in the hay secured the second year of the plant's life. At first live stock do not

relish either the hay or the green plant; but in time most animals eat both with apparent relish, though always preferring grass and other legumes.

Sweet clover seeds abundantly in its second year of growth and will thus occupy the land continuously if not destroyed by cultivation. It never makes a full stand except on lime land. Soil deficient in lime, but made up largely of clay, often produces individual plants of thrifty growth, but I have never seen on such land a stand thick enough to be profitable. The chief value of melilotus is for the renovation of the stiff, waxy, lime soils of the central prairie regions of Alabama and Mississippi where the subsoil is a soft or rotten limestone.

In Alabama yellow melilotus is not at all comparable in value with white melilotus.

The yellow comes up earlier in winter, blooms in April, and is dead by June. It never attains the size of either top or root attained by sweet clover and hence is not equal as a renovating plant. Moreover, the bitter principle is much stronger in yellow melilotus, so strong indeed as to taint the milk and butter made from it, a condition that rarely if ever occurs with white melilotus.

Note the curious fact that sweet clover like alfalfa revels in lime land. I have seen it growing with great luxuriance in piles of crushed limestone railway ballast where one would hardly think any plant could find sustenance, but that railway ballast was of limestone and full of limestone dust.

Use of Sweet Clover.—Here would seem to be the correct use of melilotus, for making land ready for alfalfa. If it is land deficient in lime put on ground limestone enough to make it alkaline, or else use burned lime if the ground limestone can not be had. Then in case the land needs humus and fertility to be made ready for alfalfa, sow to melilotus for two years. There is no magic about melilotus probably aside from the magic of its bacteria, and it will grow the better for fertilization, so fertilize it with

an application of about 250 pounds per acre of high grade acid phosphate or some better phosphate carrier. Inoculate the seed when it is sown. That is easily done if one can get earth from some alfalfa field or some sweet clover patch. Not much earth is needed; 100 pounds of earth is ample for an acre. Dry the earth in the shade, spreading it out on the barn floor, and shoveling it over now and then, making it fine. Mix the earth with the melilotus seed and sow together. Melilotus seed is sometimes seen in the hull, though seedsmen usually sell the cleaned seed. It resembles alfalfa seed almost exactly, being sometimes a trifle larger. It weighs 60 pounds to the bushel cleaned. To sow 15 pounds per acre of cleaned seed would doubtless give a stand. Mix this with the 100 pounds of inoculated soil and sow together, for thin land long run without manure, land too poor for alfalfa. If it is rich soil one would best sow alfalfa at once and be done with it, but if the soil needs building first, probably the sweet clover plant is as good a thing as one can build with. It is especially adapted to worn soils (after liming or naturally filled with lime) in southern states.

No Fear of Pest.—Some fear may be entertained lest the sweet clover becomes a pest in the land. There is no danger of that. Simply mowing the plant will destroy it as it is a biennial and must seed every second year. It often appears in alfalfa fields the first and second years after starting and sometimes the seedsmen are harshly criticised for

selling adulterated alfalfa seed. Nearly all western seed will contain a little sweet clover seed and no seedsman probably can detect it or clean it out. It is not a serious injury to the alfalfa and disappears completely the third year when the alfalfa is mown off in regular rotation. There is never any difficulty in getting rid of melilotus when one gets ready to dispose of it. It is very much hardier than alfalfa and probably a better forager for plant food; certainly it thrives on poorer soil than alfalfa does and it does very much to make the land ready for alfalfa wherever it grows. It does not ask for as deeply drained land as does alfalfa. On the other hand animals usually scorn to eat it, though I have seen it eaten with relish by sheep, pigs and cows in Alabama, and the animals throve.

The seed usually sells a little cheaper than alfalfa. Should there develop much demand for it there would be large profit in producing seed on suitable soil, since it seeds very freely almost anywhere, while alfalfa does not.

Melilotus in Kentucky.—As indicative of what melilotus is doing in Kentucky we quote the following extracts from letters written by J. T. Mardis, from Pendleton County:

As an illustration of its value, I will explain that seventeen years ago I bought one hundred acres of as badly worn and washed land as could be found anywhere. My first resolve and constant efforts following was to improve and get in grass, and to obtain these results I worked all my spare time, year after year, filling washes with any material to be had, plowing, harrowing and sowing grass seeds and seeds of many different plants advertised and recommended for improving land, for which

I spent hundreds of dollars, but as the land was too poor to take in grass to do any good, the labor and seed were lost, as the condition of the land grew worse with each season until seven years ago, when I took up sweet clover, with the result that to-day the land is in fine shape, either being cultivated and producing good crops or in fine blue grass sod, and while producing this effect the land yielded an abundance of pasture and hay. And oh, what a relief to be rid of the sight of those unsightly barren and washed hillsides.

It is a biennial, makes fine pasture the first season and abundant crop of pasture, hay or seed the second season. There are two varieties—white and yellow—the latter being generally preferred for hay, as it does not grow so coarse; it grows from two to four feet high, while the white will double this growth under same conditions, and makes splendid hay if properly managed; makes more and later pasture and builds land up much quicker. Each is good for all kinds of stock; does not bloat cattle or sheep; is one of the best honey plants known. It is a leguminous plant, the strongest within our knowledge. When once established it requires no further seeding as it reseeds itself. After it has once seeded, the land may be cultivated two or three years and a good stand follow without reseeding.

Sown at any season of the year, you are sure to get enough to secure a catch by waiting and allowing it to seed and spread, but of course it is desirable to get a good stand at once, for which I advise sowing from Dec. 1 to March 1, on top of land without covering. Or if sown later, say to the first of May, it should be harrowed or brushed in.

It can be sown with small grain of any kind either in spring or fall. If sown in early fall it should be covered sufficiently deep to prevent germination until spring. Good results are had by sowing on stony washed and barren hills during the winter months without previous preparation of the land, as the seed will be carried down by the frequent freeze and thaw. The seed should never be sown on snow or hard frozen ground, as it is liable to be carried off by following rains. Good blue grass sod can be had in three to four years on this class of land by sowing the two seeds together; all grasses do much better grown with sweet clover.

To illustrate the rapidity with which sweet clover is gaining favor, I will state that in 1903 I saved one bushel of seed. In 1904 I saved four bushels of seeds. I wrote articles which were published in the county paper, describing its habits and qualities. I continued to recommend it locally and in 1905 saved

thirty bushels of seed which were readily taken, and later in the season the demand could not be supplied at any price. As a result hundreds of acres of land in this and in one or two neighboring counties, so worn and washed that it was almost worthless, has been and is being brought back to a state of productiveness and value.

In regard to seed, there seems to be no established market as to prices or number of pounds per bushel. It is sold at all kinds of prices per bushel, the bushels ranging from 14 to 60 pounds per bushel.

There is also a vast difference in the quality of the seed, as to how it is cleaned and handled, as it heats very readily even in small bulk, consequently there is much dead seed sold, which fact has discouraged many would-be growers.

I recommend the sowing of unhulled seed as a cheaper seed as something else is often substituted for the hulled.

It should be cut when the first blooms appear and handled much the same as other clovers, giving a little more sunshine, according to weight of crop. For hay I advise sowing the yellow blossom variety on hand where the machine can be run. More feed of fine quality can be had per acre from this plant than any grass I have ever seen. For improving land and for grazing I strongly advise using the white variety. I do not recommend sweet clover for low or wet land.

We have recently purchased 200 acres more of the same class of land and will soon have this in the same present condition of the first 100 acres purchased. During the spring of the extremely dry season of 1908 we broke for corn an old timothy meadow where patches of sweet clover had been started, and all during the season, after the corn had started, it was easy to see where the sweet clover had grown, and these spots were the only part of the field where we had any corn which was fairly good, and the rest of the field yielded only fodder of poor quality.

Mr. James Thompson, an all-round business man and director of the Pendleton Bank at Falmouth, has purchased a few hundred acres of worn out land which he has seeded to sweet clover and is well pleased with the investment and says he knows of no other plant so valuable to those having worn out or washed land.

Mr. J. S. Gardner, Kelat, Ky., stock buyer and shipper, says: "The fattest sheep and cattle I handle are those from sweet clover pastures."

Milch cows fed on sweet clover hay yield an abundance of milk from which is made nice yellow butter. Stock cattle, young horses and mules do well on the hay without grain.

Land is just as easily broken after a heavy crop of sweet clover as after common red, if plowed before the seed plants have made too much growth. Seedling plants do not interfere with wheat. The yearling plant is a little in the way of harvesting, but does not injure the crop, unless it should be very thick. It will grow just as well on the poorest stony washed limestone land as on the best of soil. The land cannot be too dry and hot for it to succeed. It does prepare land for alfalfa by loosening, enriching and furnishing the necessary bacteria. It is a drouth resisting plant, and continues to grow through the dryest summers, furnishing an abundance of grazing, while other grasses are parched, and remains green until quite hard freezing. Sweet clover is all right on good land, but it is the man with the worn land who needs it most. On dry land such a thing as an entire failure is out of the question if good seed is sown, no matter at what season of the year, but of course you may expect best results from spring seeding where the seed is covered by any means convenient, or from early winter sowing, when nature will do the covering. When sown for hay I use one bushel of seed to four acres, for grazing or improving land one bushel will be sufficient for five or six acres. If sown late in the season and the weather is dry the seed will lay over to the next spring and come all right. Some of the best stands I have ever had were obtained from such conditions.

Some of the statements made may seem a little extravagant to those not familiar with the plant, yet there is not a particle of exaggeration. Just imagine a growth from six to eight feet high and so thick a man can scarcely walk through it, being left on the land to enrich it and stop wash and to be followed without cost the next season with a growth of seed plants that will form a dense sod and grow to the height of two to three feet, and this process repeated year after year, and add to this the fact that this plant unquestionably attracts to the soil more than double the amount of nitrogen that red clover will under the most favorable conditions. Can you then wonder that land is so rapidly improved?"

In Wyoming.—The Wyoming experiment station reports that lambs fed upon sweet clover hay relished it and throve. It was found that they digested it exceedingly well, and that it contained a very large percentage of digestible protein. It is well known

that animals usually refuse to eat green sweet clover. It seems that when made into hay, with a little salt added, they relish it.

The Wyoming experiment is thus reported:

Sweet clover throughout most of the eastern states is considered as a weed and is treated as such. At this altitude, under our peculiar conditions, it is believed by a few that there is a future for it, since it grows well. It is an alkali-resisting plant and, although it is not palatable to stock in the green condition, yet after it is cured, especially where salt has been added, the stock relish it and thrive well upon it. It is very nutritious, readily digestible, and contains an exceedingly high percentage of crude protein. It is more nutritious when cut at the proper period than many of the other hays.

The sweet clover hay used in this experiment was grown on the experiment station farm near Laramie in 1905. It had been in stack for over a year before being used for this experiment. It was very rank at the time of cutting and the amount of stems, therefore, very large in proportion to the leaves. The stems had become rather hard and woody. Notwithstanding this, the hay proved to be a very narrow ration, since the nutritive ratio was only 1:3.2. The crude fiber did not run as high as would have been expected, being but 24.75 per cent. The experiment was begun April 13th and completed April 26th, 1907.

Amount fed .... 3,000 grams
Amount of orts .... 00 grams
Amount of feces (air dry) .... 1,118 grams

ANALYSIS.

	Water.	Ash.	Ether extract.	Crude fiber.	Crude protein.	Nitrogen-free extract.
Feed	7.81	10.75	1.58	24.75	15.74	39.37
Feces	6 27	9.41	2.89	42.32	10.44	28.67

AMOUNT IN GRAMS.

	Dry matter.	Ash.	Ether extract.	Crude fiber.	Crude protein.	Nitrogen-free extract.
Fed and consumed	2,765.7	322.5	47.4	742.5	472.2	1,181.1
Feces	1,047.8	105.2	32.3	473.1	116.7	320.5
Digested	1,717.9	217.3	15.1	269.4	355.5	860.6
Per cent digested	62.12	67.38	31.86	36.28	75.28	72.86

DIGESTION COEFFICIENTS OF SWEET CLOVER HAY.

	Dry matter.	Ash.	Ether extract	Crude fiber.	Crude protein.	Nitrogen-free extract.
Sheep 1	58.44	65.36	32.91	27.14	75.33	70.52
Sheep 2	62.08	64.62	28.06	37.48	75.77	72.74
Sheep 3	62.12	67.38	31.86	36.28	75.28	72.86
Average	60.88	65.79	30.94	33.63	75.46	72.04

The digestive coefficients of sweet clover hay are entirely satisfactory. It seems that the great objection to the hay is the flavor and the fact that it becomes woody if it is allowed to ripen. It is believed that there are possibilities for this plant in Wyoming if it is cut at the right time and properly cured and cared for. It grows well and the yields are large. The nutritive ratio is 1:32.2, as found by this experiment, which makes sweet clover a narrower ration than alfalfa.

PHOSPHORUS FOR SOILS.

Phosphorus is the "life" of the soil. Scientists are not agreed as to the function of phosphorus in the soil, some contending that as applied it is merely a sort of disinfectant, as it were; that it destroys certain toxic or poisonous conditions hurtful to plant life. Certain it is, however, that soils well stored with available phosphorus are productive of the right sorts of useful plants. Soils well stored with phosphorus are rich soils, grow rich plants and make splendid animals. The soils of the central blue-grass region of Kentucky are so rich in phosphorus that the addition of more can not usually be seen in the crop. They are rich too in carbonate of lime and from these soils grow the best grasses in the world, and the horses and cattle feeding on these grasses are famed the world around.

Soils that are poor and unproductive are usually much helped by applications of additional phosphorus. Alfalfa especially responds to this element.

Basic Slag.—Basic slag has already been mentioned. It is a refuse left from making steel. Certain ores rich in phosphorus make bad steel unless that element is taken out of them. John W. Paterson of West Scotland Agricultural College, Glasgow, in an admirable pamphlet on use of "Basic Slag on the Farm," says:

The essential constituents of manures are nitrogen, potash

and phosphoric acid for the sake of the crop, lime for the sake of the land.

At the outset of cultivation size of crop will generally be determined by the supply of the first three. After a term of years the ability of the soil to respond to fresh applications of artificial manures will largely depend on its holding a sufficiency of lime.

The use of most of the ordinary artificial manures involves the washing out of lime into the drains. Thus the application of 1 cwt. sulphate of ammonia will, in ordinary circumstances, cause an ultimate loss of more than its own weight of available lime compounds in the drainage of waters. After a long period of artificial manuring the use of ground lime as a soil corrective has been rapidly gaining prominence in recent years.

It is in view of this fact that among all artificial manures basic slag possesses a special interest. While primarily employed as a phosphate, it contains ground lime as an accidental constituent. Bones do not cause waste of available lime compounds from the soil. Basic slag actually increases them. All other artificial manures in common use, nitrogenous, phosphatic and potassic, cause a gradual washing away of the lime compounds from the land.

Manures are applied not because the land is ever actually deficient in nitrogen, potash or phosphoric acid at the time. They are applied rather because the natural supplies of these are in a form unsuitable for absorption by plants.

The importance of lime in land is that it hastens the conversion of the natural soil constituents into available forms. This effect is exercised on the phosphates, on the potash, but above all on the nitrogen. The general effect of liming on newly broken in land, especially on peats, which are commonly deficient in lime, is sufficient evidence of this.

Leguminous crops, including clovers, vetches and beans, do not require nitrogenous manures because they are able to utilize atmospheric nitrogen. Lime greatly strengthens their power to do this, thereby giving larger crops and enriching the land in nitrogen at the same time. Basic slag has the same power partly owing to the extra lime which it contains, the effect being usually best seen in the stimulation of clovers in pasture leys.

Basic slag is a by-product in the manufacture of steel by the basic process. Pig iron frequently contains phosphorus; and steel made from this is brittle unless the phosphorus is removed. In the process of manufacture a blast of air is forced through the molten pig iron, whereby the phosphorus in the pig is burned to

give phosphoric acid. This acid then unites with lime thrown into the molten metal for the purpose. A phosphate of lime is formed. This rises to the surface of the metal as a fusible slag, and is subsequently poured off and cooled. A dark, brittle, hard mass is obtained, which is capable of extremely fine grinding in roller mills.

In 1886, Dr. Hilgenstock showed that basic slag phosphate exists as a hitherto unknown compound of phosphoric acid and lime, viz., a tetra-basic phosphate $(CaO)_4P_2O_5$. Later investigations showed that this phosphate, if only sufficiently ground, passes easily into solution even in very dilute acids. In a sample shaken up with peat and water, 78.8 per cent of its phosphate was dissolved in 14 days. The suitability of basic slag phosphate for direct absorption by plants was thereby demonstrated.

The special characteristics of basic slag as a manure are (1) the easy solubility of its phosphate in dilute acid, (2) the presence of free lime giving what is chemically called an alkaline reaction. In both these respects basic slag is superior to bones. Super-phosphate, the other principal source of phosphoric acid, is superior in solubility, being water soluble, but inferior in its general effect upon soils, being deficient in lime. These differences in character of the three manures are seen in their relative effects as crop-producers in carefully conducted experiments.

The capacity of leguminous crops to utilize atmospheric nitrogen renders nitrogenous manures generally unnecessary. For the same reason farm yard manure, which supplies much nitrogen, can in most cases be better utilized upon some other crop. The most profitable return will in ordinary practice be obtained from a dressing of artificials supplying phosphates, potash and lime.

Beans, vetches and peas are all lime-loving crops, and for this reason basic slag is well suited to their requirements. Belonging to the same natural order are sainfoin, lucerne and clover, important forage crops. For these, 5 cwt. basic slag, and 2½ cwt. kainit in autumn, is recommended as a suitable application, with 3 or 4 cwt. superphosphate, and the same quantity of kainit again in spring. The quantities stated may require to be increased or diminished according to the fertility of the land.

While the necessity of applying manures to land under crop is now almost generally recognized, the claims of pasture strangely enough are almost wholly neglected. Recent investigations have shown, however, that this is a mistake. More especially is this the case with the medium and second-class pastures, which form such a large proportion of our grazing area.

Practically speaking, all such pastures will yield a profitable return to a suitable application of manures, and in some cases the natural yield may be even trebled.

Attention was first directed to the improvement of pasture land by Dr. Somerville, while director of the Northumberland County Farm at Cockle Park. His experiments were started in 1897, and the results to date are published in a report by his successor, Prof. Gilchrist. The plots receiving different manurial treatment are each 3 1-20 acres—three acres being grazed each summer, while the odd fraction is cut for hay. The live-increases of the sheep and the yields of hay are carefully noted during each year, and compared with the unmanured plot. Ten different systems of manuring were contrasted in the experiments, but the following four only need be referred to, as they were most profitable of the various methods:

PLOT.	MANURES.	Cost of manures.	Mutton produced (6 years).	Profit from manures	Hay per acre (6 years)
6	Unmanured	....	246 lbs.	....	59 cwt.
3	10 cwt. slag, 1897	22 s.	822 lbs.	158 s.	164 cwt.
4	5 cwt. slag,* 1897, same 1900	22 s.	662 lbs.	108 s.	133 cwt.
5	7 cwt. super,* 1897, same 1900	36 s.	642 lbs.	88 s.	124 cwt.
8	Same as plot 5; ½ ton ground lime, 1897, same 1899	56 s.	769 lbs.	107 s.	138 cwt.

*Containing 100 lbs. phosphoric acid.

The profit is estimated from the extra mutton produced over and above that on the unmanured plot. It is valued for the purpose at 3¾d. per pound, live weight.

Basic slag here has proved at once the cheapest and most profitable form of fertilizer on pasture. Its superiority to superphosphate (Plots 4 and 5) seem to be due to the fact that besides containing easily available phosphate it also contains free lime. Comparison of plots 5 and 8 bears this inference. The land at Cockle Park is stiff clay, and has been under pasture for over thirty years.

Basic slag is purchased on its percentage of phosphate of lime. The quality varies from about 20 to 45 per cent phosphate (equal to 9 to 21 per cent phosphoric acid). The higher grades are usually rather cheaper per unit. The unit prices of different samples may be ascertained by dividing the prices per ton by the percentages. Other things being equal, the quality which supplies the unit of phosphate at the lowest cost on the farm should be purchased.

I devote this amount of space to basic slag be-

cause I have seen such good effects come from its use in England, and because it did equally well on Woodland Farm. It will never perhaps be cheap enough for use west of the Allegheny Mountains, since it is all imported from England or Germany, but along the Atlantic seaboard it is now probably as cheap a source of phosphoric acid as anything known. With basic slag one gets quite a little lime free of cost, since usually there is about 55% of carbonate of lime in basic slag. It should sell for about $1 per unit; that is, a slag analyzing 18% phosphoric acid should sell for $18 per ton, when it is about as cheap as any other source of phosphorus with the lime thrown in.

In England on old pastures basic slag works miracles. There with the sowing of no seeds at all clovers spring up and cover over the land, almost crowding out the grasses. The lime has sweetened the soil, the phosphorus fed it, the clovers result. Later the decay of clover leaves and stems fill the soil with available nitrogen which in turn feeds the grass. When will we learn in America to feed soils?

Other Sources of Phosphorus.—Prof. Alfred Vivian, of the Ohio State University, so clearly and concisely states the composition of phosphatic fertilizers in his admirable little book, "First Principles of Soil Fertility," that we here quote:

Phosphoric acid is present in the soil in much smaller quantities than potash, and experience shows that it is much more likely to become exhausted. In fact, there are sections of the country where no other fertilizers than those furnishing phosphoric acid are used, while these are bought in large quantities.

All this class of fertilizers contains its phosphoric acid in the form of phosphates, i. e., the phosphoric acid is combined with some basic substance, which is generally lime. The phosphates may be subdivided into two general classes—the natural and the manufactured phosphates.

Natural Phosphates.—There are two general sources of phosphates—the bones of dead animals, and certain phosphate-containing minerals, which will be briefly considered.

Raw bone meal is made by grinding raw bones to a powder, and the finer it is the more valuable the product. This substance contains about 22 per cent of phosphoric acid and 4 per cent of nitrogen. Raw bones contain a small quantity of fat as well and, as this prevents rapid decay of the bone, the phosphoric acid and nitrogen in the meal are somewhat slowly available to the crop.

Steamed Bone meal.—Most of the bone meal sold at the present time is made from bones previously steamed to remove the fat and a part of the nitrogen compounds. The fat is used in making soap and the nitrogen in glue and gelatins. Steamed bone contains from 28 to 30 per cent of phosphoric acid and about 1½ per cent of nitrogen. The steamed bones can be ground to a much finer powder, and the removal of the fat causes them to decay more rapidly, so that they must be considered a more valuable source of phosphoric acid than the raw bones.

Mineral Phosphates.—In a number of places rock deposits are found that contain varying percentages of phosphate of lime. These phosphates are usually named after the place where they are obtained, as, Carolina phosphates, Florida phosphates and Tennessee phosphates. These rocks contain from 18 to 32 per cent of phosphoric acid, and differ from the bone products in that they are purely mineral substances and contain no organic matter. Ground into a fine powder, they are sometimes sold under the name of floats, but the rock phosphates are used only to a limited extent in the crude condition.

Superphosphates or Manufactured Phosphates.—The phosphoric acid in all of the natural phosphates described is combined with lime in a form that is extremely insoluble in water. In order to make the phosphate soluble it is sometimes treated with sulphuric acid, which unites with part of the lime, leaving a phosphate which contains only one-third as much lime as the natural phosphate, and which is soluble in water. The lime and sulphuric acid make a compound which is the same as that found in gypsum or land-plaster. This combination of soluble phosphate and gypsum, made by treating the natural phosphates with acid, is called by the various names of super-phosphate, soluble

phosphate, acid phosphate or acidulated rock. For its manufacture the rock phosphates are generally employed, both because they are cheaper and because the organic matter in the bones interferes with the use of sufficient acid to make all the phosphate soluble. A good sample of super-phosphate or acidulated rock contains about 16 per cent of phosphoric acid in a form that is soluble in water. Sometimes when insufficient acid has been used a part of the soluble phosphate will change into a form intermediate in solubility between the natural phosphate and the acid phosphate, and the acid phosphate is said to have undergone reversion, and the new compound is called reverted phosphate. The latter product is supposed to be more available to the plant than the insoluble or natural phosphate, hence the soluble and reverted phosphoric acid taken together are known as the available phosphoric acid.

In some instances bone meal is treated with a limited amount of sulphuric acid and the product is called acidulated bone. This substance contains a much smaller proportion of its phosphoric acid in the soluble form than does the rock superphosphate. When soluble phosphates are added to the soil they soon combine with the mineral matter, and are converted first into the reverted phosphate, and finally into the insoluble form such as is found naturally in the soil. In this way the phosphoric acid is fixed and there is no danger of its being lost by leaching.

Relative Value of Phosphate Fertilizers.—The soluble phosphate present in the acidulated goods is generally considered the most valuable form of phosphoric acid for use as a fertilizer. At first sight it seems useless to go to the expense of making the phosphate soluble when it is again rendered insoluble by the soil before the plant can make use of it. The real object in making it soluble is to aid in its distribution in the soil. When an insoluble phosphate is applied it remains where it falls except for the slight distribution it receives by cultivation. In the case of the soluble phosphate, on the other hand, the phosphate dissolves in the soil water and is widely distributed before it becomes fixed by the soil. In the former case the roots must go to the phosphate while in the latter the phosphate is carried to the roots. It follows from what has been said that after the soluble phosphate is distributed throughout the soil the individual particles must be very much smaller than is the case with the insoluble phosphate.

There are some soils upon which the superphosphates cannot be used without injury, usually those that are deficient in lime, the superphosphate in such cases having a tendency to make

them acid. Indeed it is even asserted that soils containing an abundance of lime in the beginning may be made acid by the continued use of superphosphate if no lime is added.

When the natural phosphates alone are considered there is no doubt that the preference should be given to those derived from bones. The organic matter present in the bones decays when it is incorporated with the soil, and this process doubtless causes the phosphate to become more readily available to the plant, while the rock phosphate on the contrary is very slowly decomposed. The degree of fineness to which bone meal or mineral phosphate is ground is of prime importance. Very fine bone meal is much more available than that which is coarser and is always rated at a higher price a ton.

Using Floats with Manure.—The use of floats, or finely ground phosphate rock, has not met with general favor, and it probably does not give good results when used alone. Some of the earlier experiments indicate that it has practically no value as a source of phosphoric acid for the plant. Recent investigations at the Ohio and Illinois Experiment Stations show that when floats are added to farm manure it has a very high fertilizing value; in fact the increased crop production in Ohio due to adding the ground rock phosphate to the stall manure was nearly as large as that obtained from the addition of superphosphate. The acid substances produced during the decay of the manure apparently make the phosphoric acid in the rock more available, and it would seem from these experiments that the comparatively inexpensive floats might, partially at least, replace superphosphate if used in connection with the manure. Other experiments have demonstrated that good results can be obtained from the use of ground rock phosphate when plowed under with a green manure crop like clover, but that it is of very little value if used on a soil low in organic matter. In a plot experiment at the Massachusetts experiment station two "equal money's worth" of ground Carolina rock and superphosphates were compared. In this case the superphosphate proved superior at first, but within a few years the plot to which rock phosphate was added gave higher yields. It would seem, on the whole, that the use of floats with manure is worthy of a trial by anyone needing a phosphate fertilizer. Ohio Bulletin 134 recommends that the ground rock be used "as an absorbent in the stable, thus securing an intimate mixture with the manure in its fresh condition."

Raw Phosphatic Rock for Alfalfa.—Raw rock, or floats, the natural Tennessee, South Carolina

or Florida phosphatic rock, is the basis of the fertilizer called acid phosphate, or acidulated bone. It is made into acidulated form by the addition of about as much sulphuric acid as is taken of finely ground rock.

The raw rock contains a large amount of phosphorus, but it is not in an available condition to be taken up by plants; at least this is the general supposition. Experiment, however, shows that when the finely ground phosphatic rock is put in contact with decaying organic matter in the soil it does become available and plants feed upon it. A given amount of money will purchase about two or three times as much phosphorus in the form of raw rock as it will purchase in the acidulated form.

J. F. Jack on his farm in eastern Virginia has given the raw rock a careful test and with very marked results. The rock was applied at varying rates, from 250 pounds per acre to 1,000 pounds per acre. Check strips where no fertilizer was applied were left. The result showed conclusively that the raw phosphate was available and where 1,000 pounds per acre was applied the result was a splendid growth of alfalfa. Even the application of 400 pounds gave good results, though it is not probable that it would be nearly so permanent. Fully as good results were obtained with the raw rock on this particular soil where a heavy growth of crimson clover had been turned down and about 1,000 pounds per acre of water-slaked lime was used, as was had from raw bone, 400 pounds, or acid phosphate, 400 pounds.

It is not yet safe to say that upon all soils the result would be the same, but on this particular soil, somewhat acid, with a heavy growth of green clover turned under, there is no mistaking the great saving resulting from the use of the raw rock.

Upon this same soil potash seemed to give no noticeable result, nor could be found a strip where was applied nitrate of soda at the rate of 100 pounds per acre. It was indistinguishable, showing that the decaying crimson clover furnished all the available nitrogen needed for the growth of the little alfalfa plants.

There was left one plot with no inoculation. The result was most astonishing. Where the land was inoculated with soil evenly spread the alfalfa stood thick and strong, knee high and more. Where no inoculation had been applied it was thin, weak, crowded with weeds, many plants less than 2″ high.

Phosphates on Alfalfa.—Even on good land I have found it very profitable to sow some sort of phosphate with new sown alfalfa. The phosphorus certainly greatly stimulates the little alfalfa plants and makes them hustle to get ahead of the weeds and grass. Thus stronger stands result. Also less seed may be sown to the acre than if no phosphorus is used. The writer and his brother have used on Woodland Farm raw bone meal, acid phosphate and basic slag with about equal reults so far as the eye could see. It is our practice to put on 250 to 400 pounds per acre of 16% acid phosphate when the alfalfa is sown in soils well filled with lime. Acid

phosphate is about the most soluble of the phosphatic fertilizers and thus is best for top dressing when there is abundant lime in the soil. When there is suspicion that there may not be lime enough then basic slag or bone meal should be used, unless lime also is applied. Acid phosphate dissolves away a part of the lime in the soil. That is its one bad feature.

As has been stated the alfalfa meadows on Woodland Farm get an annual dressing of phosphorus young and old alike, and this practice pays well.

Fertilizer Distributer.—On Woodland Farm we own a wide and large fertilizer distributer. This machine sows a strip 8′ wide and the box holds 1,000 pounds of fertilizer. It simply sows the stuff broadcast on the surface. There are various types of these machines. The American Seeding Machine Co., Springfield, Ohio, makes one, and another is made by the Peoria Drill and Seeder Co., Peoria, Ill. With such a machine a man can go rapidly over his old meadow, or sow his phosphorus over his land preparatory to seeding his alfalfa. Time is the thing hardest to command on most farms in the spring; many would fertilize their meadows if they were not otherwise too busy. With these large wide sowing machines a man can rapidly get over his fields. No one should hesitate to buy the fertilizer, since a dollar so invested will usually return three or four in the crop of hay.

Adding to Fertility.—There is here a striking thought. Since our farms east of the Missouri

River are nearly all of them deficient in phosphorus, if we buy it and use it on alfalfa meadows, then feed the alfalfa hay and put back the manure, we are steadily adding to our capital of fertility; not much is lost, only we sell away in the bones of our cattle, pigs and sheep a part of it and in their flesh and blood a little more. An alfalfa farm may thus become a great laboratory of fertility gathering, provided the crops are fed on the farm. When they are sold off the story is different.

How Much Phosphorus?—In England it is the custom to apply very large amounts of basic slag to their meadows and pastures far in excess of what the plants can take up, and they seem to get large profit from so doing. There is lack of careful experiment to show us what amounts of phosphorus will pay best sown with or on alfalfa. The requirements of the plant, that is, the amounts actually taken away from the soil, are as follows: 1,000 lbs. of alfalfa hay contains 5 lbs. of phosphoric acid; 4 tons, or 8,000 lbs., would then contain 40 lbs. of phosphoric acid. Two hundred and fifty pounds of 16% acid phosphate would contain that amount, and should make good what was removed from the soil by the 4 tons of hay. That there should be abundance in supply the writer advises the use of 300 lbs. annually of 16% acid phosphate, or proportional amounts of the stuff, if a different percentage is bought. Thus if only 10% of available phosphoric acid is present one would need to use 400 lbs. or more. So it is cheaper and better to use only

the high grade fertilizers containing large percentages of available phosphoric acid.

How Well Will This Pay?—In most of the eastern United States a 16% acid phosphate can be bought for $14 to $16 per ton. Thus 250 lbs. would cost about $2, and the labor of applying it about 30c. Thus to fertilize an acre costs less than $2.50. The yield of hay will be increased in proportion to the need of phosphorus, but on Woodland Farm it has been as much as 2 tons of hay per acre increase, and thus this additional hay cost us only $1.25 per ton. Could we have afforded to have left this land unfertilized?

The plain fact is that farming is, after all, a manufacturing proposition. The land is the factory. Its fertility is the raw material. A man would be thought inconceivably foolish who would through stinginess refuse to keep his factory supplied with raw materials, thus letting his machinery work to only half of its capacity. The alfalfa meadow, the corn field, these plants are our machines. Feed them with their required raw material.

POTASH AS A FERTILIZER.

Most soils derived from granitic rocks have in them a lot of potash. Most soils in the glaciated area of eastern and central America seems to be quite well supplied with potash. Some sandy soils are deficient, and peaty lands, where once old pond bottoms were, are especially deficient. To grow alfalfa on peat or to grow corn there one must use potash.

Testing with Potash.—As a rule on ordinary upland clays and clay loams potash seems not to be lacking. Very often where it is applied to such soils no result can be seen. It is wise for each farmer to make test of this matter for himself. Let him procure a few hundred pounds of muriate of potash and apply it in strips over his fields, marking the ends of the strips so that he can see the result, if there is any. About 200 lbs. per acre of muriate of potash is a moderately heavy application.

Wood Ashes.—Wood ashes may contain 8% of potash and 2% of phosphoris acid. There is also some lime in them and other minerals in small amounts. Wood ashes have an especially good action on alfalfa. It is an interesting truth that no one has yet been able to compound a fertilizer that would have the same effect as wood ashes, though the ingredients were so mingled that chemically the two materials were nearly identical. Nature has done some-

thing with wood ashes that man can not imitate very well. The writer has secured splendid results from use of wood ashes on soils that did not seem to need potash. I advise that all wood ashes be saved with care and whenever there is a saw mill or any other wood-burning furnace nearby the ashes should be secured and applied to alfalfa land. Wood ashes are applied in varying amounts, from 500 lbs. to one ton per acre.

PLOWING THE SOIL.

Plowing is an ancient art. The height of a land's civilization is very nearly to be measured by the sort of plowing done there. What is plowing for? It turns under loose stubble, trash and vegetation, putting it down into the soil where it may decay and by its decay help set free mineral plant food. It loosens the earth to let air in and this promotes important changes in the soil. It lets the water sink down into the soil, hence plowed lands are moister and will withstand drouth much longer than unplowed lands.

There are certain crops that seems to thrive on shallow plowed soils. Alfalfa, on the other hand, seems to thrive best where the land is plowed deep. In older lands than ours, where agriculture has advanced very far towards a perfect system, deep plowing is much practiced. In France some plow a foot deep and even deeper. On the Island of Guernsey men often plow a field twice, the first plowing shallow, the second one crossways and going down as far as 16″. On such lands alfalfa thrives especially well. In France and Algeria men plow for alfalfa full 20″ deep.

Why Deep Plowing Suits Alfalfa.—The reason why alfalfa likes the land plowed deep is doubtless because the letting in of air and moisture favors the life of alfalfa-promoting bacteria. These

thrive especially well in soils where the air can penetrate easily. The bacteria supply alfalfa with nitrogen. Thus deep plowing is equivalent to feeding the alfalfa with extra nitrogen. The heaviest growth of alfalfa that I have ever seen was on the ranch in Utah where I once lived, the plants standing 48″ high all over the field and very thick. The underlying soil there was of loam, interspersed with layers of loose sand and gravel, a soil that was too easily drained, not very fertile, but well filled with lime and other alkalies. With copious irrigation that land produced enormous crops of hay.

Deep plowing in a manner imitates such a condition by letting in the air and storing up more moisture as well. Of course one must use judgment. If his soil is of poor clay with only a thin skin of vegetable mould on top one dares not bury that deep under the clay and plant maize thereon, but it is probable that he could do it and plant alfalfa with success, especially if the land was well drained and limed.

The water-holding power of deeply plowed soil is about double that of unplowed, or shallow plowed soil. This is important when it comes to getting maximum crops of alfalfa hay. The lack of moisture is usually the limiting factor in crop yield, a fact not half appreciated as yet.

How to Plow Deep.—I have done some experimenting on a hard clay soil with numerous small round boulders or "niggerheads" in it in trying to plow deep. It is not an easy task. In this especial

soil on Woodland Farm the top soil is rather poor in lime, leached away by the erosion of centuries of rain. Down about 16″ are many limestone pebbles. Could these be thrown up by the plow the result would be the same as a heavy liming—be better, in truth. How do we know this? By the behavior of land that has been tile drained. Where the ditches are dug the subsoil is mixed with the top soil—in fact in filling the subsoil is usually left on top—and there will grow the best alfalfa without question. Even in a dry year the effect is very marked, the narrow strip of land where the tile ditch stood sending up alfalfa like a ridge, often 12 or more inches taller than the rest of the field. The effect is more marked on a dry year than on a wet one, so it can not be attributed to the effect of underdrainage altogether.

We have found that with a large common breaking plow we could go down 10″ easily enough, if the land was not too moist nor too dry. After that a smaller plow can follow and go 4″ or 5″ deeper. Not much of this last soil will be thrown clear of the furrow, but it will become well mixed through with the top soil. Woodland Farm has only begun experimentation along this line, but we are quite well persuaded that by the time the reader sees these lines we will have abundant proof of the great use of this deep plowing. We are ready to advise only in fairly fertile soils, especially if the subsoil has more lime than the surface, a depth of plowing of 12″ or 16″ or as deep as you can go.

Plowing, like the tariff, is "a local matter," so each farmer had better test the thing for himself. On his own soil deep plowing may not work so well. It is easily tested on a small scale in any event.

Subsoiling.—A subsoil plow is one that merely runs in the furrow and loosens up the underlying soil. It does not bring any of it up to the surface. Subsoiled land has much greater water-holding capacity than before it was subsoiled. Sometimes this fact is a detriment, if the land is poorly drained. It is difficult to subsoil land that has in it boulders or large stones. Subsoiled land erodes less than other land, because the water sinks readily into the subsoil and there is thus a great reservoir of saturated earth which in turn gives moisture to the overlying soil. In all hilly regions where there is danger of erosion, as in east Tennessee, subsoiling has been found to be a more useful practice.

Not so much work has been done in subsoiling for alfalfa as should be done. I have only done such subsoiling as I described in the ditching work done on Woodland Farm. That has convinced me, however, that some day much land will in some way be loosened up here and the yield of alfalfa be increased at least 25%, and probably more.

On the Rappahannock River, in Virginia, J. F. Jack has tested subsoiling in a limited way and the result has been very markedly good. In truth subsoiling tested alongside of additional fertilization gave markedly superior results. Other men have related to me their experiences with subsoiling, but

so far as I am aware nothing has been done in experiment station work along this line. On all hard clays and wherever it is desirable that more water be stored in the subsoil I advise the use of the subsoil plow. It would certainly be wise to test it in a small way at first, then if results seemed good it could be adopted as a part of the regular practice.

In Europe it is not unknown to trench or dig up a field with spades to a depth of 36″, mixing top and bottom soils, and land thus treated, well limed, well manured, yields crops that would astonish an American farmer, even if living on the richest soils.

Plowing for Spring Sowing.—When alfalfa is to be sown in the spring it is well to get the plowing done early, this so that the land will settle together again and make a better seedbed for the seedling plants. Freshly plowed land is too loose to hold moisture near the surface well. Thus it is best to plow for alfalfa in the fall or during the winter. If lime is to be applied it is best to apply it immediately after the plowing, or after one dragging of the land. Then it is disked in and mixed well with the soil.

If the plowing can not be done early it may be done immediately before seeding, but then more care must be taken to firm the soil again and make a good seedbed. Going over it several times with the disk harrow is one way to firm it, or to roll it with a heavy roller and afterward disking it will bring the top soil into capillary connection with the subsoil.

It is not so necessary to get a perfect seedbed in spring sowing as it is when sowing in the fall. There is much more moisture in the spring and heavy rains will probably come to compact the seedbed, yet drouths are to be looked for at any time, so one should do his part well in any case.

Example of Spring Sowing.—Take Woodland Farm, where always of recent years seeding has been done early in April. This farm is about on the 40th parallel, in the latitude of Columbus, O., Philadelphia and Springfield, Ill. Spring seeding is done here because of the climate and soil. Singularly enough at this point on the curve of the earth there seems more fighting of the elements than either north or south of us. At Wooster, O., some 80 miles north of us, snow and frozen ground prevail during a much longer time in winter than with us. Thus at Wooster they find fall seeding of alfalfa a better thing than spring seeding, while we have had very poor success indeed with fall seeding, which usually lifts out of the ground during the repeated freezes and thaws of winter.

Disk, Harrow and Drag.—Land destined for alfalfa is almost always planted to corn the year before and given very clean and careful cultivation. For the corn crop as much manure as was available was applied. The land is plowed in the fall or winter if there is time and the soil is found fit. The plows are set to run as deep as practicable. In this practice we are reforming steadily year by year, deepening our soil as fast as we well can. As soon

as danger of hard freezing is over, say by April 10, when the land is dry enough to be fit to till, we go afield with disk harrows. The cutaway double disk harrows suit us very well for this purpose. Following the disk harrow goes the slant-tooth smoothing harrow, which levels the land quite well. After the smoothing harrow goes the plank drag. This makes a smooth surface, free from clods. The drag is made of three planks, about 2x12, lapped together like shingles and bolted together. The drag makes drilling easier and a better seed-bed.

Sometimes the fertilizer is sown before the land is dragged, sometimes afterward. This point is not very material. As already described, we commonly sow acid phosphate of about 16 per cent grade, because it is cheaper with us than bone meal or any other carrier of phosphorus. We sow no potash except on black peaty soils, once beds of swamps. Lime we have applied earlier; it is best to have it incorporated with the soil some weeks or even months before sowing the seed when this is possible.

Seeding with Drill.—After the drag comes the drill. We use a drill with grass seed attachment that sows both barley and alfalfa seed. The alfalfa seed is sometimes set to fall in front of the drill and sometimes to fall behind, depending somewhat on the nature of the soil. On stiff clay land it will not do to bury alfalfa seed very deep. On lighter looser soils they will come up through an inch of soil.

The drill is set to sow two bushels of beardless spring barley to the acre. This barley does not stool heavily. It is not a very prolific barley either, but it makes a good nurse crop for alfalfa. The facts that it does not often lodge and does not much shade the young alfalfa are all in its favor.

SEEDING AND CUTTING.

About 15 pounds of alfalfa seed are sown. We have used more and have used as little as 8 pounds. In the long run there seems little difference in the yield of hay, but on the whole we prefer to use 15 pounds of seed.

Work After Seeding.—If the land is very dry, we follow the drill with a roller. We seldom do this, however, since there is always danger that rain may follow and further compact the land, making it hard for seeds to get up. We very much prefer to get the under part of the seedbed firm before putting on the seed. We sometimes follow the drill with the plank drag again. We aim always to leave the land quite level and smooth, so that the mower will run nicely.

Inoculation.—With us no inoculation is needed, nor was it ever needed seriously on Woodland Farm. Just why this was true we can not imagine except that our father had allowed some few clumps of melilotus to grow and that he had always used a good deal of manure. For some unexplained reason manured land is nearly always inoculated with alfalfa bacteria, illogical as the statement seems. Inoculation comes in about a month, little nodules by that time appearing on nearly every rootlet.

Further Treatment.—It is seen how easily we

sow alfalfa, with what slight labor and expense, yet magnificent stands are secured in every instance We have not one record of failure where this system has been followed on Woodland Farm except in a few spots where the barley lodged badly and was not soon enough removed.

The further treatment of the field is to let it alone till the barley comes into bloom. Then we go in with mowers and cut it all down and make it into hay. By that time the alfalfa will be needing a clipping. Sometimes we wait till the grain is beginning to form in the heads, but usually we take off the barley hay earlier than that.

Time to Cut.—The test of when young alfalfa is ready to clip is when the plants put out little buds or shoots down near the ground, at the bases of the stems. It ought never to be clipped before then. After that time it ought to be clipped promptly, as one must not cut off these new shoots with the mower. We have said this before and will repeat it again as the point is so essential to success.

Why Make Barley Hay?—Why do we not let the barley ripen its grain? Because if we were to do that it would seriously weaken the young alfalfa. Ripening grain takes a tremendous amount of moisture from the ground. It also not infrequently lodges and this smothers out the young alfalfa. Very little shading or mulching will kill it. So it is better to make hay of the barley. It makes good hay; all animals love it. It is more profitable made into hay than used in any other form.

BARLEY AS A NURSE CROP FOR ALFALFA.

Subsequent Cuttings.—When the barley is taken away the alfalfa comes vigorously on and makes another cutting in about 40 or 50 days. The time to cut this is judged by the buds or shoots upon the stems, just as at the first. This is in fact the inviolable rule in cutting alfalfa if you would preserve its vigor and productiveness.

After this cutting it is left strictly alone. No one trespasses again on the alfalfa, no animals graze it, no mower invades its domain. It may be 24 inches high when killing frosts come; no matter; leave it stand and next year you will gain all that and much more with it.

Value of Barley Nurse Crops.—Why the nurse crop with spring sowings? First, because there is pretty good profit in beardless barley hay. We feed it to all our animals. The alfalfa has grown about as well for the presence of the barley as it would have grown alone. And the barley rather subdues other annual grasses. There is a curious principle in Nature that some plants are deleterious to other plants. Cockle burrs, for instance, poison land for corn, and where barley grows well foxtail grass is not so much seen. Then when the barley is taken away the alfalfa seems to push right on, almost unmolested. We can get a much better stand of alfalfa with a nurse crop of beardless spring barley than we can to sow it alone, and we get the barley hay as a clear gift.

Other Nurse Crops.—Why not choose oats as a nurse crop? With us they are not nearly as de-

sirable. When oats are left to ripen their grain a poor stand of alfalfa is almost inevitable.

I have often sown oats with alfalfa, mowing them for hay when in bloom with good results. When oats are sown no more than a bushel of seed should be sown to the acre. If the soil is very rich and the seedbed very good three pecks per acre will be enough seed, or even a less amount. Oats stool much more vigorously than barley and thus thicken up and shade the alfalfa plants too much.

Oats must be mown off earlier even than barley to leave good stand of alfalfa. When the little stamens begin to hang out from the oat heads then cut for hay at once. Or if the oats should lodge mow immediately and remove from the ground. Oats make more hay than barley, but it is harder to cure.

Flax has sometimes been used as a nurse crop for alfalfa with pretty good success.

Alfalfa is sown in wheat successfully in some places. It is absolutely necessary that the land be previously inoculated, or that the inoculating earth be put and harrowed in before the alfalfa is sown, or failure will surely result. It is necessary to harrow the wheat and make a fair seedbed so that the alfalfa seed may be covered. On the whole, wheat is not a good nurse crop for alfalfa, since if the soil is rich it is apt to lodge and smother out the baby plants.

Cowpeas, soy beans, rape, Canada field peas, all these things have repeatedly been tried with no

success whatever. They shade too much and smother out the alfalfa.

Fall rye sown in the spring is advocated by a New Jersey man who used it thus nearly 100 years ago. I have not tested it, but have my suspicions.

Alfalfa may be sown with corn at the time of last cultivation in July. Thus sown it makes almost a stand, never quite a perfect stand. The corn robs the land a little too much of moisture to allow the alfalfa to get rightly rooted. There is also a little too much shade. Should alfalfa seed ever become cheap again it would pay to sow it in corn for soil improvement, even if it was turned over next year in late May and again planted to corn.

Where Are Nurse Crops Permissible?—In Ohio, Illinois, Indiana and probably Iowa and Missouri a nurse crop may be often as good a thing as it is on Woodland Farm. Much depends upon whether it is intelligently used. To sow grain thickly and to let it ripen on the land may very likely prove most injurious to the alfalfa. If a man knows his failings, if he is too greedy to cut the nurse crop at the right time, or too careless, he had better not sow one at all, but sow the alfalfa alone.

West of the Missouri River it is usually too dry to permit the use of a nurse crop. South of the Ohio River it is safer and better to sow alone in the fall or mid-summer with no nurse crop.

It is most tempting when one sees a magnificent growth of oats or barley on the land to say, "I must let that ripen; it is too fine to cut down for hay";

and the letting it ripen will usually damage the alfalfa stand about 25 to 50 per cent. I have repeatedly asked a lady for a half-cup of tea and never in my life found but one who could give it! All the rest would fill the cup full. So if the reader is one of the few men who can resolve to cut his nurse crop for hay at the proper time, he should, if he lives in a similar climate to ours, use a nurse crop. Otherwise he should sow alfalfa alone.

Fall Seeding of Alfalfa.—There seems a large area where fall seeding is more successful than spring seeding. Where fall seeding succeeds it is the cheaper way. The use of the land is not lost for any appreciable time, and often one gets a full crop of some sort of grain before seeding his alfalfa. Northern Ohio seems adapted to fall or rather midsummer seeding of alfalfa; also New York, in parts at least, a good deal of Pennsylvania and much of Maryland, Virginia, Kentucky and Tennessee. In Missouri some practice one way, some another; Kansas and Nebraska seem to get good results from fall, or better, mid-summer seeding. In Iowa summer seeding is advised.

The reason why alfalfa usually thrives when sown in mid-summer or early fall is that then there is less crowding by weeds and especially by annual grass. Furthermore, alfalfa is a heat-loving plant and it pushes rapidly forward if the seedbed is good and it gets started in late July or August. It is very essential that the seedbed be good, and no pains should be spared to make it so.

Spring Plowing and Summer Sowing.—Some have practiced spring plowing of the land and afterward harrowing it after every rain, after every appearance of weed growth, until all the weed seeds are killed, then sowing the alfalfa alone in July. Usually this results in a good stand. The cost is considerable. No return from the land is had at all for one year and the repeated harrowings cost quite a little. It is one of the surest ways, perhaps, of getting alfalfa started in land very foul with grass and weeds. I do not advise this plan except in cases where it is extremely difficult to get a stand. By harrowing well after each rain nearly all of the moisture is conserved. Thus it is a plan well adapted to use in semi-arid regions where it is not easy to establish alfalfa because of lack of moisture in the soil. In such situations the land should be plowed in the fall and disked after each rain or snow fall and all care possible taken to conserve the moisture that falls. After once the land is moist down to a depth of a foot or more and a thoroughly good seedbed is secured then the alfalfa may be sown, though in such situations it is usually well to defer sowing till August. The state of tilth of soil and the amount of available moisture are more important determining factors, however, than the time of year in dry regions, where alfalfa does not heave out by frost in any event.

I can not from my own experience recommend this plan of seeding for any states in the cornbelt region, since it is an unnecessary expense and no

more successful, so far as I have seen, than several other less costly plans.

Seeding After Early Potatoes.—The land may be plowed early and deep, fitted as soon as it is ready to work and planted to potatoes, choosing some very early maturing variety. There is hardly any better plan than this. The potatoes well repay high manuring and fertilization. They should have plenty of phosphoric acid given them; in the eastern states it is common to give early potatoes as much as 500 to 1,000 pounds of high grade acid phosphate per acre; potash also usually tells a good tale when applied to potatoes. Thus if the crop is highly fertilized there remains a good surplus in the soil available to the alfalfa.

The potatoes well repay good cultivation and thus weeds are destroyed and when the potatoes are dug the land is left clean and thoroughly well loosened up. It is an easy matter then to level it off, disk it well and get ready for alfalfa seeding. This can usually be done in July and as soon as the potatoes are fit to dig and sell they should come out to make room for the alfalfa, the more important crop of the two by odds.

Do not plow the potato land. Disk it very thoroughly, then disk it again. If the soil is too dry to make alfalfa grow, wait for rain before sowing the seed. Should there come a shower, disk again and wait for a rain that will moisten the underlying soil. There is danger in sowing alfalfa seed in the dust, expecting rain to come and bring it forward.

Rain may come, certainly, but often in only sufficient amount to bring the seed up, or merely to germinate it, and underneath there is dust. Thus the seedlings perish before they can get their rootlets attached to the subsoil. So wait till there is moist soil enough not merely to bring up the seeds but to let their rootlets feed and penetrate on down.

Inoculation an Aid.—When sowing alfalfa either in July or August one must remember that the time until fall and killing frosts is short, so do all that he can to hurry it forward. Thus it is well if the land has never had alfalfa on it before, nor ever been manured with manure made from feeding alfalfa hay, to inoculate the soil. Inoculation hastens growth in young alfalfa immensely. Soil from a successful alfalfa field, or soil from a patch of melilotus or sweet clover, or soil from where burr clover grew is usually successful in inoculating alfalfa. The various cultures of beneficent bacteria have not worked well in field practice, we regret to say. So take earth from some other field and inoculate the place you expect to put your new sown alfalfa in. There are various ways of distributing this inoculation. If the soil has been thoroughly well limed, or is naturally well stored with carbonate of lime, and if it has had some manure, inoculation will "take" in it and go through the field very rapidly, once give it a start.

Seeding.—Sow it in any manner most convenient, either through a wheelbarrow seeder or through a drill, taking great care not to drill it in too deep.

Go immediately over the land with an efficient harrow, trying to cover the seed one inch deep. It is no harm to apply more fertilizer at the time of sowing this seed. It will only push the young plants the more rapidly forward.

In Ohio, Pennsylvania, Indiana, Illinois and other states of like climates this seeding should be done in late July or early August. It is essential to get the plants strongly rooted before winter sets in with its frosts and cold. The stronger the root the less liability to winter killing.

Subsequent Treatment.—No clipping, no pasturing nor any other treatment should be given the alfalfa this season. Simply let it alone and keep all animals out of it. The only thing that might cause a man to meddle with it would be if he should discover some dodder in the field. This should be destroyed as soon as seen. Pull up the infected plants and burn them. Throw down a little straw on the spot where the dodder has appeared and set it on fire. Dodder is worse than fire to alfalfa. No other weeds will be apt to trouble. If any large, coarse weeds should come up they may be pulled up by hand.

There is hardly any better way of starting alfalfa than this if a man has a liking for potatoes. The crop usually pays well for use of the land, and the alfalfa crop comes on strong and is secured at the least possible expense.

Summary.—Summarizing the process of sowing alfalfa after potatoes, the essentials are, first, selec-

tion of good dry rich land, with plenty of lime in it, or else applying liberally of lime before planting.

Deep plowing and somewhat high fertilization for the potato crop. Planting as early as practicable of a very early-maturing variety of potatoes.

Very careful cultivation that will conserve all possible moisture and destroy the weeds well.

Digging as early as possible and immediate preparation of the soil for alfalfa.

Inoculating when needed with soil from a successful alfalfa field or a sweet clover patch and sowing the seed as soon as there is a good seedbed and enough moisture in it. Covering the seed about an inch deep with the harrow.

Leaving the alfalfa alone, no matter how high it gets, leaving all the growth to protect it in winter.

Fall Seeding After Wheat.—It is often desirable to sow alfalfa after a crop of grain. This is practical enough if the season proves not too dry. Alfalfa best follows a crop of winter grain, since that ripens earlier than spring sown grain. Perhaps the worst defect in the practice of following alfalfa after wheat arises from the fact that if the land is as fertile as it ought to be to grow a heavy crop of alfalfa the wheat is apt to lodge. There are soils, however, so well balanced that they will grow both excellent wheat and heavy crops of afalfa. I have seen in France wheat as high as oxens' backs, yet not lodged at all, growing on alfalfa sod, and destined to grow alfalfa again in the regular rotation.

Preparation for Crop.—When alfalfa is to follow wheat the land may be well limed in the fall before the wheat is sown, if it is in need of lime. As early as possible the wheat shocks should be taken off and immediately the plow started in the stubble. Now is a dangerous time, since one may so easily lose his moisture and get instead of a seedbed a mass of sunbaked clods that no harrowing will reduce to fineness. To avoid this each half day what land is plowed should be fitted by use of harrow and drag, or perhaps use of roller, followed at once by harrow. It is not sufficient to fit each evening what has been plowed during the day, but each half day's work must be completed within that half day. This is also much the easier way. An hour spent upon freshly turned land will do more than a half day after the furrows have dried out into hard clods.

Be not content, either, with a half preparation of the land. Do a good job of it. Use drag, disk and smoothing harrow. Make the earth fine. Seal up in it all the moisture it holds. It is work well spent. Since it must be done in any event it is wise and economical to do it immediately it is plowed, when an hour's work is worth a half day's later on. In order to do this best it may be well to let the man who does the plowing work till about 9:30 in the morning, then, unhitching from the plow, hitch to the plank drag and go over what he has plowed with that. Unhitching from it, hitch to the disk harrow, and after disking then go over it with the slant-tooth smoothing harrow, which finishes it pretty well and

effectually seals the land so that no moisture can escape. Of course if several teams are plowing one man may follow steadily with tools for fitting the land.

Save the moisture. It is wise not to sow the seed before there is plenty of moisture stored. In this connection the reader should study the preceding advice upon summer seeding. Save all the moisture you have and accumulate as much more as you possibly can before sowing the seed. And yet one can not safely delay sowing longer than till about the 10th of August, and if it can be sown in a good seedbed with sufficient moisture by the first of August all the better. The time of sowing is a local question. In Louisiana one can safely sow the last of October, yet north of the Ohio River late July and early August sowing is much safer than any later sowing.

Inoculation in Advance.—It is well to inoculate the soil for this fall seeding, and the reader is asked to note with care what has been written elsewhere on this subject. One way of getting this inoculation in a wheat stubble is to sow some alfalfa seed in the wheat in March. If 5 pounds are then sown and harrowed in with a sprinkling of inoculating earth, say 100 pounds to the acre, and the soil and seed mixed together, it is probable that a fair growth of alfalfa will result and the inoculation spread throughout the whole land. Then when the land is plowed again and the young alfalfa turned under the inoculation will be spread. Quite a little benefit

will be seen from the fertilizing effect of the young alfalfa turned under. And further one can judge quite well by the growth of this spring sown alfalfa as to the state of fitness of his land, whether maybe it needs more lime, more drainage or further enriching. The cost need not concern you, since with good inoculation present less seed need be sown in the fall. Indeed 15 pounds of seed sown on a good seedbed well inoculated will give a better stand than will 30 pounds sown on a poorly prepared seedbed or without good inoculation.

Ordinarily it is of no use to sow alfalfa seed with the wheat in the fall. It usually perishes during winter. There are soils and climates, however, where it will succeed fairly well thus sown, and by this means good inoculation could be had. Five pounds of seed to the acre with about 100 pounds of inoculating earth should be sown then.

All in all, to sow after wheat is a good practice wherever fall seeding is desired and a soil-building cover crop is not needed to prepare the land for alfalfa growing. The one danger is that there may not be enough moisture stored to give good fall growth. The alfalfa must not be clipped nor pastured the fall it is sown. The next year it is cut three or four times, as would be any ordinary alfalfa field.

Alfalfa After Spring Barley.—Spring-sown grain has some advantages for alfalfa sowing. For one thing the soil is more easily got ready for alfalfa after the grain is removed. Then these grains are

not so apt to lodge if the soil is rich. Beardless spring barley is particularly appropriate here. It ripens very early and does not often lodge. It is almost impossible to make the soil too rich for spring barley. It is advisable to plow the land for these spring crops and to plow it deep. It is well always to sow a small amount of alfalfa seed with the barley. If it is the custom to sow 20 pounds of alfalfa seed in the fall it will be much better to sow 5 pounds of this in the spring at time of seeding the barley. This will help the inoculation very much indeed and the 15 pounds sown in the fall will give a better stand than would the whole 20 pounds sown at that time.

The same rules laid down for sowing after potatoes and wheat apply with equal force for sowing after spring barley and should be studied.

The one trouble with all this scheme is that it presupposes a very fertile soil and quite a little rainfall in late July and August. Given these things one ought to succeed admirably following this plan.

Alfalfa After Oats.—What has been said of seeding after barley applies fairly well to oats. The field should be well plowed in spring. Five pounds of alfalfa seed should be sowed to each acre to promote inoculation. If no alfalfa has ever grown on the land and inoculation is doubted, soil should also be spread or sown and promptly harrowed under. Then the oats if cut off for hay will leave a far better seedbed than if allowed to ripen. Ripening oats draw tremendously on the soil moisture. It is a great help to mow them off for hay when coming

into bloom. Thus the land may be prepared very much earlier for its destined crop of alfalfa.

Alfalfa After Crimson Clover.—Where the climate is mild enough to permit its growth crimson clover forms an admirable preparatory crop for fall sown alfalfa. The subject is mentioned in an earlier chapter, but I will here sum up its advantages and manner of use. Crimson clover is an annual. Sown in the late summer it grows during the fall and whenever it can during warm days in winter. It makes very rapid growth in spring, blooms in May, ripens seed and dies. It is not a good clover for forage unless fed off green. Half ripe crimson clover heads are dangerous when fed to animals, making "hair balls" in their stomachs and killing them sometimes. A fairly good crop of crimson clover will yield to the soil as much nitrogen as would cost $15 per acre, if one were to purchase it in the bag. It comes off or goes under early enough to make easy the preparation of a good seedbed. There is seldom danger of insufficient moisture when crimson clover is the crop preceding alfalfa, supposing the land to be well managed after the clover is ready to turn under.

On the other hand crimson clover does not thrive well without inoculation, and natural inoculation seems absent except along the Atlantic seaboard. Doubtless artificial soil inoculation would result in great gain with this plant elsewhere. Crimson clover provides a great deal of very valuable humus.

Mr. Jack's Use of Crimson Clover.—In eastern

Virginia, under the direction of C. V. Piper, J. M. Westgate and Nicholas Schmitz of the Department of Agriculture, J. F. Jack is sowing what may be well termed an alfalfa ranch. His estate consists of nearly 2,000 acres along the Rappahannock River. When Mr. Jack took this land much of it was in a most impoverished condition.

The land is first plowed and planted to corn with 250 pounds per acre of raw bone meal. Sometimes other fertilizers are used. The plowing is deeper and more thorough than the land has ever known before.

Next, at last cultivation of corn, crimson clover seed is sown at the rate of about 20 to 30 pounds per acre. A small growing wild hairy clover is found on these fields that probably inoculates the crimson clover and it grows well. In May this crimson clover is knee high all over the fields. Then it is turned under, plowing about 8 inches deep. Lime is put on, either ground limestone at the rate of about 2 to 3 tons per acre or burned lime. Intensive cultivation is given the land till August, the purpose being to store the land with as much moisture as possible.

Then men come and sow with hand labor inoculating earth. This Mr. Jack can get from his own farm, though originally he had it shipped to him from sweet clover beds along the Potomac River. Immediately behind the men who distribute the earth walk other men with wheelbarrow seeders and distribute alfalfa seed. Behind these men come

harrows and almost instantly the seed and inoculating earth are covered up. The fertilizer is usually 400 pounds per acre of raw bone meal, though other sources of phosphorus have been used as well.

The result is as certain as mathematics. Mr. Jack at Belle Grove gets stands of alfalfa every time, good, thrifty, healthy, profitable alfalfa.

It is very notable, however, that wherever Mr. Jack has applied a little manure there he gets much stronger crimson clover and much heavier alfalfa as well. It is not yet proved that a man can build successfully very poor soils without manures. Certainly the work is greatly accelerated when manures are available.

I have treated at some length the experiences of Mr. Jack because I know of no more important work being done anywhere in the east. Here one sees land taken in impoverished condition fairly representing millions of acres of farming lands in the older eastern states, unprofitable to farm, worthless as an investment unless redeemed, and by application of plain and well tested agricultural principles brought rapidly into profitable culture again. Mr. Jack's success, doing this work on a large scale and as a business venture, is a lesson in soil building and business methods in farming of illumining importance to the whole farming world.

Rate of Seed per Acre.—There are in a bushel of alfalfa seed about 14,000,000 seeds, more or less, according to their size and weight. Thirty pounds to the acre then would put about 160 seeds to the

square foot—something over one seed to each square inch of soil. An alfalfa plant requires about 16 to 25 square inches of space. Thus use of 30 pounds of seed is from 16 to 25 times too much, supposing that each seed dropped made a living plant. When sown in drills one pound of seed is enough for an acre, and seeding in drills will be a practical scheme in America.

One pound of seed per acre makes approximately five seeds to each square foot. There ought to be nine plants per square foot to make a good stand on ordinary soil fit for alfalfa growing. That would require two pounds of seed, sown broadcast, if every seed made a plant. The germination of alfalfa seeds is not usually perfect; often with the best seed only about 75 per cent will germinate the first year. And not every seed will be covered right for germination. Thus if we allow half to perish for lack of right planting we will come to a need of four pounds of seed per acre to give an ideally perfect stand.

As a matter of fact this amount is often sown. Where one desires to grow alfalfa seed a thin stand is better than a thick stand and four pounds of seed will suffice. Of course one must be sure of his seed-bed and of his seed if he ventures to use so thin a seeding. And he ought to be sure that the land is inoculated. On inoculated soil a thin seeding will give a better stand than a thick seeding will on un-inoculated soil.

The Ohio experiment station has made an inter-

esting test of this very matter and the results are herewith recorded:

The Ohio station put out a thick and thin seeding test of alfalfa June 27, 1907, at the rates of 5, 10, 15, 20 and 25 pounds of seed per acre. The seed was distributed through the grass-seeding attachment of an ordinary wheat drill after repeated and careful testing. It was dropped in front of and covered by the drill hoes.

The results of this test thus far appear in the following table:

THICK AND THIN SEEDING OF ALFALFA.

SEED USED PER ACRE.	No. plants per sq. foot July 31, 1907.	No. plants per sq. foot May 2, 1908.	Total pounds hay per acre, 1908 (3 cuttings).
5 pounds	13	11	7,862
10 pounds	33	27	8,648
15 pounds	45	34	8,678
20 pounds	56	44	8,557
25 pounds	70	49	7,876

It will be noted that the maximum yield was harvested from the plot receiving 15 pounds of seed per acre, but that 10 pounds of seed gave within 30 pounds of as large a yield of hay per acre. The yield from 20 pounds of seed is somewhat lower than from 10 and 15 pounds, and the yield from 25 pounds decidedly lower, exceeding the yield from 5 pounds by an insignificant amount.

It should be stated that 5 pounds of seed per acre proved a little light in so far as holding the weeds in check is concerned. If a few large weeds had not been removed from this plot it would have presented a somewhat ragged appearance. This being done the quality of the alfalfa was as satisfactory as on any plot.

This ground was in ideal condition for alfalfa when seeded, having been plowed some eight weeks previous and harrowed at intervals of 10 to 20 days until seeded. Under such conditions 10 to 15 pounds of seed per acre would seem to be enough. It is to be doubted whether more than 15 pounds of alfalfa seed per acre is needed in this state when a good seed bed is prepared, and it is surely cheaper to prepare such a seed bed than to buy alfalfa seed to waste among clods, or in a loose, dried out soil.

As a matter of experience extending over many years I advise the use of 15 to 20 pounds of seed for ordinary soils and under ordinary conditions.

While it is true that this gives a good many more plants than are needed, yet these will crowd each other out in time and about enough will survive to make an ideal stand. An extra alfalfa plant is simply a weed in the field, but it is the best weed that can be selected, and it undoubtedly deters the growth of other weeds to a greater or less extent.

Thick Fall Seeding Wrong.—Men have sown as much as 40 pounds of seed to the acre in the fall. This is a serious error. The plants standing so thickly, more than 200 of them to the square foot, so crowd each other that they can not grow as they ought, and so no root gets strong as it should before the winter sets in. The result is that the frost lifts and destroys a large percentage of them all. With half the seed sown and stronger plants more would have been alive in the spring.

Curiously enough the better the land is adapted to alfalfa growing the fewer plants an acre of it will carry. I have seen wonderful alfalfa meadows with no more than 40,000 or 50,000 plants to the acre. Each root, however, had many stools and stems, a hundred perhaps or more from the one root.

Sowing the Seed.—If the seed is sown on freshly harrowed land it is best. The seedbed should be firm, well worked down, yet freshly stirred. Thus the seed stick wherever they happen to strike and do not roll around or get in bunches. The manner of distribution is not very essential. Perhaps the most even distribution is had by the wheelbarrow seeder. Any of the commercial seed sowers on the market

will do good work in capable hands. An end gate broadcast seeder that may be attached to any wagon will do good work. It may be sown by hand if the operator understands seed sowing, or it may be sown with a drill, letting the seed fall behind or in front of the hoes, according to circumstances and the condition of the ground. The aim is ultimately to cover the seed an inch or about an inch deep. The harrow may follow the sower and finish the covering. Probably for this purpose the common slant-tooth smoothing harrow is the best implement. When seed and inoculating soil are applied together, the drill or fertilizer distributer is the best implement to use.

Drilling in the Seed.—The American Seeding Machine Co. has developed a drill that will sow alfalfa seed accurately in rows 6″ apart, putting it in at any desired depth. I have seen alfalfa sown with one of these machines, with 20 pounds of seed to the acre, that was at least 10 times too thick. It is evident that with a perfect seedbed and a proper alfalfa drill one need sow no more than 5 pounds of seed to the acre. This means a fine seedbed, firm underneath, level and smooth. The saving of seed would pay for all the labor of preparing the seedbed and the resultant thrift of the alfalfa would be very fine to see. This machine will drill in 4 pounds of seed to the acre, and to a required depth.

Alfalfa with Red Clover for Inoculation.—Whenever it is suspected that alfalfa may be adapted to a soil and red clover is to be sown there in the reg-

ular rotation, alfalfa should be mixed with the clover seed. If 10 per cent of alfalfa seed is used it will be enough to give a good sprinkling of alfalfa plants and later a thorough inoculation of the land. How this inoculation comes we do not know. Certain it is that when alfalfa is sown on suitable soil, dry and with lime enough, it becomes inoculated in a year or two by natural means. Thus two things are accomplished: One gets a good general idea of the suitability of the soil to alfalfa and he gets it inoculated so that when a little later he sows alfalfa alone it assuredly grows strong from the start.

Furthermore, the mixture of red clover and alfalfa is a good mixture anyway. It makes more hay and more pasture than red clover pure. It enriches the soil more efficiently. Alfalfa is nearly as easily established as red clover. If sown with oats or if the wheat is harrowed to let the seed be covered it is certain to make a pretty good stand mixed in this way.

Red Clover with Alfalfa.—On the other hand, some men practice sowing red clover with alfalfa. They claim that with the addition of about 20 per cent of red clover seed to the alfalfa they get a heavier yield of hay the first year following the seeding and the next year pure alfalfa results which outyields adjoining fields or plots that have had no red clover in them. That is, the decay of the red clover roots, they assert, enriches the soil for the alfalfa. This is said of some soils in Pennsylvania. In my own experience this is not a very good practice, since

it leaves the alfalfa a little thin on the ground after the clover has died out, but I have not tried it more than once or twice.

Alsike Clover and Alfalfa.—These sow well together and make wonderful forage either for soiling, feeding off for pasturage or for hay. It is best, of course, to call it an alsike field and treat it as though no alfalfa were sown in it, since the alfalfa is much more permanent than the alsike. Alsike, however, is in some soils more permanent than red clover and will sometimes last as long as four or five years. It does not cut more than one, or at most two, crops of hay in a year. Some of the loveliest pasturage the writer has ever seen has been a mixture of alsike clover, alfalfa and smooth brome grass.

INOCULATION AND NITROGEN.

Many once deep, dark mysteries are now cleared up so that we smile at what once made men despair. Alfalfa growing was once as deep a mystery as any one could name. Sown in Colorado, Utah or California alfalfa thrived from the start almost. Sown in Ohio, Illinois, Kentucky or New York it often failed. When it lived it was for some months or a year or more a feeble, unhappy, sickly plant. After a time perhaps it recovered and made wonderful growth.

Why This Difference?—Why should it behave so differently in different regions? Of course there are several answers to this query. One is that some soils are filled with lime and phosphorus, are dry and filled with air. Alfalfa loves such soils. But the other and more hidden and mysterious reason is that of the nitrifying bacteria that help alfalfa grow. These bacteria are naturally present in some soils. They live on more species of legumes than alfalfa alone. Burr clover (Medicago arabica or Medicago denticulata) carries the same inoculation, uses the same bacteria. So does sweet clover or melilotus. Doubtless there are other wild legumes growing in western arid soils that use the same bacteria. On the other hand, in eastern soils these bacteria were absent almost altogether.

One of the best illustrations of the lack of inoculat-

ing bacteria was seen in Christian County, Kentucky. A field of good limestone soil was well enriched and sown to alfalfa in the fall. A fine stand resulted and I visited it the next spring, some time early in May. The alfalfa was short, stunted, of yellow color, clearly destined to be a failure. Careful search revealed no nodules on the roots. One bunch of thrifty alfalfa was in the middle of the field, another at one edge, near where had stood a negro's cabin. I dug up these plants and found abundant inoculation, the nodules being plentiful. I dug out the soil around these spots and threw it over the field. Rains distributed the bacteria still further, so that in a year the whole field was inoculated and yielded a heavy crop of hay, about six tons to the acre. The land had been well limed.

Vital Relation of Bacteria.—What is the vital relation between bacteria and alfalfa? I make no pretense to exact scientific knowledge on this question. As near as I understand it the case is about as follows: Alfalfa is a legume. All or nearly all leguminous plants are aided in their growth by bacteria that associate themselves with the plants, living on the roots or on the rootlets. With plants using these bacteria existence without them is precarious and often impossible.

Securing Nitrogen.—The problem of fertility, of production of plants, of crop yield is a curious one. Some elements going to make up plants are mineral; these we find in the ash of plants. A large part is water; this comes easily enough from the soil. A

large part is carbon; carbon is taken from the air by the leaves of the plant. There is plenty of carbon always for plant growth. There is usually plenty of water. Mineral elements—potash, phosphorus, lime, iron and so on—are easily enough added to the soil. The sole remaining element is nitrogen. Nitrogen is one of the essential elements in the proteins of food, the albumens. Nitrogen is essential to nearly all life, animal and plant. All the higher animals need much nitrogen in their foods. All the grains have in them much nitrogen. Nearly all crops taken away from the soil remove a great deal of nitrogen. Soil waters leach it away. Since the beginning of the world everything has preyed upon the nitrogen of the soil. The rocks in the beginning held little or none of it. Whence did the soils then obtain their nitrogen supply?

Two Classes of Plants.—There are two classes, very broadly speaking, of plants in the world, the nitrogen gatherers and the nitrogen users. Corn, wheat, the grasses, potatoes, flax, oats, nearly all farm crops use nitrogen and can not get it except as it is already stored for them in the soil. That at least is as far as we know now. At any rate soils grow poor in nitrogen when crops of corn, wheat, hay or almost any crop except clover or some other legume is grown upon it. Certain crops are soil builders. Certain other crops are soil robbers. The legumes are the soil builders. They get nitrogen in some way. How do they do this?

Abundant Nitrogen in Air.—Nitrogen exists in

enormous amounts in the air. Nearly 80% of the air is pure nitrogen. Why can not the leaves take it directly in as they do their carbon from the air? That we do not know, but they can not do it. Plants will starve and perish for nitrogen with their leaves bathed in that substance, with their roots surrounded with it as well, for in all porous soils there is much air.

About Bacteria.—Bacteria do the work. Bacteria are very minute plants, sometimes almost like animals in having some power of motion. Yeast is a bacteria. They are intensely minute. It would take 5,200 of them, placed in a row, to be an inch long. Twenty-seven million could be on a square inch of space. A farmer can not ever hope to see one; it takes a powerful microscope to show one, yet any farmer can see the work they do.

It is thought that there is really only one sort of bacteria for all the clovers, but that habit has divided them into varieties, similar yet unable to live on the same plants. Thus there are the red clover bacteria, the cowpea bacteria, the alfalfa bacteria, and many more. Some bacteria live on several different plants, just as the alfalfa bacteria thrive on melilotus, alfalfa and burr clover.

These bacteria when they touch a tiny rootlet of alfalfa have power to enter it and abide there. They increase there and swarm in incredible numbers. They are really parasites upon the plant, most likely. The plant attacked puts out a protective covering, thus forming a swelling nodule on the little

rootlet. This nodule is filled with these bacteria. Nodules are not all alike; some look like little seeds, some like bunches of grapes. They vary in size and shape very much. Nodules on alfalfa plants are rather smaller usually than alfalfa seeds. They exist only on the root hairs. Evidently these bacteria prefer the new fresh roots.

The Work of Bacteria.—What do the bacteria do for the plant? In some way they digest nitrogen and assimilate it. In some way the plant gets it. How? We do not know that. Maybe they die and decay and the plant absorbs them. Maybe the plant assimilates part of them before they get old enough to die. Anyway we know that they get hold of the nitrogen that exists in the air and that comes down into the soil through its pores, get hold of it, use it and give it to the plants. That is the miracle that lets life exist on this world of ours. A happy chance? Yes, or a thought of God. It is certain that were it not for this "chance," human life, and animal life as well, would ultimately perish from the face of the earth. On such tiny beings as these bacteria does all life on the world hang for its ultimate existence. Thoughtful men have long felt alarm over the state of the world as far as the food supply of the people was concerned, all because of this very drain of nitrogen from the soils by crop growing. Dr. Cyril G. Hopkins says:

But a short time ago Sir William Crookes predicted that within thirty or forty years England would experience a wheat famine, due to the exhaustion of nitrogen in the soil, that would be appalling in its effect; and Prof. Bela Korasey's warnings to

Hungary have been even more emphatic. Indeed, Liebig, more than fifty years ago, in speaking of one of the most common methods of destroying sources of available nitrogen, said:

"Nothing will more certainly consummate the ruin of England than the scarcity of fertilizers. It means the scarcity of food. It is impossible that such a sinful violation of the divine laws of nature should forever remain unpunished, and the time will probably come for England, sooner than for any other country, when, with all her wealth in gold, iron, and coal, she will be unable to buy one-thousandth part of the food which she has during hundreds of years thrown recklessly away."

To produce good crops of alfalfa without the nitrogen gathering bacteria requires exceedingly rich soil and liberal applications of barnyard manure or other nitrogenous fertilizer. Even the rich black prairie soil of Illinois does not furnish sufficient available nitrogen for maximum crops of alfalfa. No other crop grown in Illinois requires such large quantities of nitrogen as alfalfa.

Applications of available nitrogen to Illinois soil produce crops of alfalfa which yield from two to four times as much hay as crops which obtain all of their nitrogen from the natural supply of the soil. The inoculation of Illinois soil with the proper alfalfa bacteria enables the alfalfa to feed upon the inexhaustible supply of free nitrogen in the air and the inoculated soil produces just as large crops of alfalfa as soil which has been heavily fertilized with commercial nitrogen. Nitrogen costs about 15 cents a pound in commercial fertilizers, and about 50 pounds of nitrogen are required to produce one ton of alfalfa hay and the weight of the free nitrogen in the atmosphere is equal to about 12 pounds to each square inch of surface of the earth.

In Summary.—Nitrogen is constantly being drained out of the soil by growing crops. Wheat, maize, oats, hay, nearly all farm crops take out nitrogen. It is gathered together in the grains; a grain elevator represents the fertility of many a field. It goes to the cities; it becomes the food of man. Owing to our wasteful practice, hard to reform in modern civilization, the nitrogen waste is poured into the sea. Soon would the soils of the world become

barren and mankind starve and perish if the Creative force of the world had not provided this means of renewing the nitrogen of the soil. The tiny bacteria do it. All clovers gather nitrogen from the air. Alfalfa gathers more than any other known clover unless perhaps the sweet clover be an exception. Alfalfa powerfully enriches the soil on which it grows. Bacteria make it possible to grow alfalfa. It will not grow long without the bacteria.

How to Get Bacteria.—How are we to get them, how make them most healthful and vigorous? Many schemes have been tried for getting the bacteria in the soil. They can be reared artificially in cultures, and the seed treated with the culture, when each seed ought to be coated with a film of these bacteria. Each seed sown ought to produce a plant abundantly inoculated. These are the so-called commercial cultures. The theory is good. Unluckily some influence that we do not understand, maybe the action of direct light, usually destroys the vitality of the germs and the cultures do not work. There is hardly any evidence that these cultures are successful. It is too bad that it should be true: the theory is so plausible, the results, could they be secured, would be so delightful. I believe the thing could yet be brought to work, only that with the advance of good farming it will not be long till the demand for such cultures will cease, at least as far as alfalfa is concerned. Curiously enough these bacteria are very pervasive. Once a man begins to grow alfalfa on his farm and to use manure from alfalfa hay,

very soon he has the land all inoculated so that he can not sow a field anywhere that the bacteria do not find the young plants. And when once alfalfa has grown on a field the inoculation persists for several years after it is plowed up. We do not understand these things yet. Maybe we never will. It is mysterious that even the use of manure not made from alfalfa hay, on a farm where alfalfa has never grown, should often result in inoculating the soil with alfalfa bacteria. There is no doubt of this fact. I have seen it repeatedly.

Inoculation with Soil.—Soil from a field where alfalfa has grown, or sweet clover (melilotus) has grown, or burr clover has grown, distributed over the new alfalfa field, is a safe and sure inoculation. Some suggest the danger of infecting the new field with weeds or with diseases by this practice. That danger is remote. One hundred pounds of soil will inoculate an acre quite well if it has good distribution. That much soil is taken from a small place of only a few square feet. It would contain few seeds. A few sweet clover seeds in the soil do no harm to the alfalfa anyway. No other weeds are likely to be found where good clover or alfalfa is growing.

Method of Using Soil.—How to best manage this soil inoculation? Take the soil from the surface down as deep as the land is well filled with roots. Dig it and carry it home and put it on the barn floor. Spread it, not too thin, and work it over from time to time to help it dry and make it fine

for sowing. Do not let the sun strike it even for a moment; sunlight destroys these bacteria. When you have it fine enough for sowing you can either mix it with the seed and sow both together, say 100 pounds of soil and 15 or 20 pounds of seed, sowing them on an acre, or you can sow the seed and soil separately. If you have only a small field or plot to sow, do it late in the day after the sun has ceased to shine, and then harrow it at once. If you must spread it while the sun is shining let the harrow follow immediately behind the soil sower.

One can put the soil in a fertilizer drill and drill it into the land. That is an excellent way. Anyway will do so that the inoculating soil is not exposed to sunlight, but is covered up in the ground.

Coating Seed with Earth.—The Illinois experiment station has developed a very successful way of inoculating alfalfa seed, requiring comparatively little soil for its complete success. Water is heated and enough glue dissolved in it to make the water a trifle sticky. It is then cooled and the seed is well wetted with this water. Earth taken from a good alfalfa field or sweet clover patch is made fine and run through a sieve to take out lumps, roots and stones. It is better if the earth is dry, but it ought to be dried in a dark place, at least not exposed to sunlight. The earth and seed are mixed together till each seed is coated with a film of this dry and inoculated earth. No surplus earth need be used, so each seed is coated. The seed is immediately sown and covered as fast as sown in some manner. Perfect inoculation seems to

result. Some farmers who have adopted this plan maintain that it is not even necessary to add glue to the water, though that would doubtless make it somewhat more effective.

Conditions Favorable to Bacteria.—Now to make those bacteria most healthful, most active, consider their tastes. Acids in the soil promptly kill them off. Much lime in the soil makes them very vigorous and active. So make the soil sweet with lime, alkaline with lime, not sour. And they feed on air. So let the water out of the land and the air into it. Drain and subsoil or plow deep. Then the soil is ready to work miracles for you. Then one sees coming from the land rich crops of alfalfa, many times as much nitrogen as was originally in the soil, feeding his animals, feeding the soil if the manure is put back.

Inoculation in Advance.—If one plans to sow alfalfa in a year or two he should begin by getting a source of inoculating soil on his own farm. Let him prepare a narrow strip of land across a field, lime it, drain it, enrich it, inoculate it and sow it to alfalfa. Do not say, "I will experiment here with alfalfa." Alfalfa is no experiment any longer. It is sure to grow on sweet dry rich soil with inoculation. There is no chance of failure. But on this strip you will get indication of the readiness of your field for alfalfa. If it grows there vigorously all along, and stands the winter quite well, you know that your soil is dry enough, sweet enough and rich enough for alfalfa. And from this land you

will get inoculating earth for all the rest of the farm. It may perhaps be necessary to ship in enough for the first strip, though it is today a rare neighborhood that does not have in it either some sort of an alfalfa field with inoculated plants or a sweet clover patch. Once you have the strip of inoculation on your farm you are independent; you can go on and enlarge as fast as you please. An acre of inoculated alfalfa would give soil enough for inoculating at least an entire county.

Searching for Inoculation.—It is astonishing how few farmers have ever seen a nodule on a clover root. They are easily found, especially on some sorts of clovers. One can pull up almost any thrifty red clover root and find nodules in place, looking like little white seeds. On the red clover they are found on the larger roots, as well as on the finer root hairs. The little creeping white clover has nodules in plenty and they are easily found. Alfalfa has nodules only on the smaller finer root hairs. Thus they are not to be seen when one pulls violently a plant from the soil, especially if the earth is hard and clayey. The little nodules remain in the earth. They are very easily dislodged from their hold on the roots. One must take the roots out with some care and perhaps will need to wash the earth away to find the nodules the first time. After he has seen them once and knows what to look for he will find them more easily the next time.

Appearance Reveals Inoculation.—After one knows alfalfa well he can tell at a glance whether

a field or plant is inoculated. If it is of a rich green color, if it is growing fast, if it looks healthy and happy, be pretty sure that it is inoculated, whether you did it or Nature did it. If, on the other hand, it looks pale and yellow and unhappy and is crowded by weeds and altogether miserable, be sure that it is not inoculated.

Inoculated Soil a Fertilizer Laboratory.—Consider what is doing in an inoculated soil where conditions are right and alfalfa is growing thereon. Take the yearly growth at only 4 tons per acre. Four tons of alfalfa hay contain about 176 pounds of nitrogen, 40 pounds of phosphorus and 128 pounds of potash. Nitrogen is sold for about 15 cents per pound in various forms, often for a much higher price. Phosphorus is sold at a low price for 5 cents per pound. Potash is worth about the same price. Thus in the crop of 4 tons of hay we find nitrogen largely gathered by the bacteria worth $26.40, potash worth $6.40, phosphoric acid worth $2—all these from one acre yielding only 4 tons of alfalfa hay. The total is $34.80. The manurial value of this yield is vastly more than this amount, since the humus contained is worth more to the soil than one can well estimate. And the value to the soil is nearly double this estimate since we take no account of the root growth, also stored with nitrogen. Prof. Voorhees estimates the fertilizing value of an acre of alfalfa well grown to be about $65, in comparison of course with commercial fertilizers bought.

Soil Building with Alfalfa.—One must not rashly

conclude, however, that alfalfa used in any way is a soil builder. There is reason to suspect that alfalfa is one of the most energetic searchers after potash and phosphoric acid known to the soil. The roots go deeper, penetrate more, dissolve more than those of most plants.

Thus if the alfalfa is all sold off from the farm it may become steadily poorer and poorer. It is certain that it would be poorer in mineral elements. There have been instances under the writer's observation where the land has grown alfalfa continuously for some years and nothing returned, where after a time it would not grow alfalfa any longer, nor anything else very well. Exhaustion of available phosphorus would seem to be the most reasonable explanation of this phenomenon. In some instances where alfalfa has grown well for some years and then failed it has been impossible to reestablish it on the same land. This has occurred where hay has been sold off and nothing returned to the soil.

Alfalfa is a vigorous soil enricher, provided the forage is fed on the farm and the manure religiously returned to the land, not necessarily to the very field where the alfalfa grew, but to some adjoining field. Thus the one field builds another, the two may be set in alfalfa after a time and they will build a third and in this way through the magic of alfalfa roots a whole farm may be redeemed from the scourge of poverty and barrenness. Thus may vast stores of nitrogen be gathered. One may need to buy phos-

phorus, possibly potash, often lime, but nitrogen, that most costly and most vital of all soil ingredients, he is getting every day in immense amounts by the magic of alfalfa roots and their tiny allies the alfalfa bacteria.

ALFALFA IN CROP ROTATION.

With some men alfalfa is the best money crop that can be grown. Naturally these men desire to keep their land continuously in alfalfa. They practice something like the following system: After the last crop of hay is cut in the fall the alfalfa stubble is plowed deeply and fitted and sown back to alfalfa in the spring. Or the alfalfa is mown off in May or early June, again in July, and is at once broken and sown to alfalfa in late July or early August. In some parts of Maryland alfalfa winters well the first year but kills the second winter. Thus they sow it each year and declare that no crop pays so well as forage for dairy cows.

There may doubtless be instances where this is good practice for a time. It is true, nevertheless, that soils are better off to have a change of crops now and then, and crops are certainly better for fresh soils. While alfalfa is a soil enricher in the sense of adding stores of nitrogen it is a soil depleter so far as phosphorus and potash and lime go. More than that, there are hidden influences that we do not understand that make soils unfriendly to plants that have grown in them too long. It is notable that some of the very oldest books on agriculture in referring to alfalfa say: "It endures for many years and afterward may be plowed up and the land sown to corn. Land should not be sown

again to lucerne (alfalfa) till it has rested for some seasons." It is safe to assume that the ancients had seen signs that alfalfa best liked fresh land.

Alfalfa culture is too new in America for us to know much about this question. It is the practice on Woodland Farm to grow alfalfa for four years on a field, sometimes for a longer time, then to plow and plant twice to corn (maize), after which the land is sown again to alfalfa. Some of our fields have had alfalfa on them for about 12 years all told. We do not think that we see any signs yet of deterioration. In some instances we see that the alfalfa is much more vigorous than it ever was. We feed the soil, however, with phosphorus when growing alfalfa and with manure when growing corn. It is doubtless better to let a crop of some cereal or roots intervene between the crops of alfalfa and if two years intervene it may be wiser; we do not know.

There are yet no serious diseases of alfalfa prevalent. On soils well stored with carbonate of lime alfalfa seems so vigorous and healthy that it resists disease most markedly. Yet there are illusive and hard to determine causes that make soils sicken of plants of one order and produce more vigorously of plants of a different order in rotation.

Alfalfa in the Rotation.—It is often objected that alfalfa does not fit well into a rotation, that it is too long in getting established, too feeble an infant, and demands too long a use of the land.

On land well suited to alfalfa growing it establishes itself as soon as does red clover. The following

year after being sown it will make a half more hay than will red clover and the hay is of better quality. It may then be plowed under as red clover would be, or it may continue another year with more profit, while red clover can not, since that plant is almost biennial in its nature. So it is certainly not true that alfalfa can not fit into a rotation, no matter how short it is.

Even as a catch crop in corn I found when I mixed red clover, alfalfa and crimson clover together and sowed at last cultivation that I got more plants through the winter of alfalfa than of either of the other clovers. Doubtless on good lands, filled with lime, alfalfa as a manuring crop to be sown in corn would be more profitable than almost anything that could be sown. The difficulty in the way of this use is that usually the seed is too dear and when one gets a stand of alfalfa he sees too much profit in leaving it to let him desire to plow it under.

How Long Should Alfalfa Stand?—This is very much a local question. We have instances of alfalfa fields 10, 20 even 40 years old that have never been re-seeded. I have walked over fields that were said to be 40 years old and they were yet in vigorous production. This was in Texas, near San Antonio. This book is not written for men who can grow alfalfa in that way; they need no books save pocketbooks. The fact that alfalfa is such a long-lived plant in dry regions with well drained soils and dry, warm winters has worked to mislead men living farther east or north. If they could forget that alfalfa

in some countries lives ten or a dozen years or more the men of Iowa, Illinois, Ohio or New York would be better off. The simple truth is that after the first year alfalfa is in its prime. It may yield as much the third year or may not. It will often begin to decline somewhat on the fourth year and may be notably less productive on the fifth year. By the sixth year the owner begins to wonder whether, after all, alfalfa is as valuable a crop as he had supposed and his neighbors begin to say "I told you so!"

Now had this man turned under his alfalfa after it had given him 3 or 4 years of cuttings he would have had some twinges of conscience and pangs of remorse at what he was doing, and his neighbors would have called him a fool for "killing the golden goose," but he would have in the long run made more money and alfalfa would never have gone into disrepute.

Suggested Rotations.—In Ohio, Indiana and Illinois maize (corn) is king. Nothing else pays so well as corn and alfalfa, with animals to eat the stuff they pile up. Hence the most profitable rotation here will likely be, corn two years, alfalfa with barley one year, alfalfa alone three or four years, according to soil, then corn again, two years, and thus on around in regular rotation.

Rotation for a 300 *Acre Farm.*—Corn two years, barley and alfalfa one year, alfalfa three years, means a 6-year rotation. Let us see what one would get in that rotation each year. Say the fields are of 40 acres each; then he has 80 acres in corn on alfalfa

sod, after the rotation is once under way. This corn ought to yield at least 85 bushels per acre, and may yield more than 100 bushels. One field will be on alfalfa sod simply, the other field will be corn stubble heavily manured. Thus there will be about 7,000 bushels of corn, shelled measure. The next field will be a 40-acre field sown down to alfalfa with barley, either fall-sown alfalfa on barley stubble or spring-sown alfalfa with barley as a nurse crop. In the one case there will be about 1,000 bushels of barley grain, maybe more, and no hay from this 40. Then there will remain three fields of 40 acres each in established alfalfa, one of them sown last year, one the year before, one the year before that. These fields will yield about 4 tons of hay per acre, maybe more, or say 450 to 500 tons of hay.

We have left about 60 acres for permanent pasture, orchard, barn lots, woodland and so on. Now let us sum up what we have as a yield from the 300 acre farm: corn, 7,000 bushels; barley, 1,000 bushels, or else, barley hay, with some alfalfa in it, 50 to 75 tons; alfalfa hay, 450 to 500 tons. Pasture left 60 acres, which will keep the work teams, cows and pigs during summer and give a good place for animals to run and exercise in cold weather when it will not do to let them step on the alfalfa field.

As working horses need little or no grain in winter when they have good alfalfa hay it seems clear that the 7,000 bushels of corn will about balance the 450 tons of hay. If there is need of more corn to feed out the pigs it can be bought. If cattle or sheep are

to be fed, or dairy cows kept, one can hardly have too much alfalfa.

The cash value of these crops would be about as follows: The farmer could not sell all of the 7,000 bushels of corn since his horses must be fed. He could sell 6,000 bushels, for say 50 cents per bushel or $3,000, or he could sell of his hay, 400 tons, by feeding his corn stover to his cows and work teams; the hay would be worth about $8 per ton as an average low price, or $3,200 or more. The 1,000 bushels of barley would be worth say 60 cents, or $600. The gross returns then from the 300 acre farm devoted to corn and alfalfa would be around $6,800. And if one bought what phosphorus his crops took out of his soil it is probable that he could keep on selling off these crops for some years. It would certainly be far better to feed the crops, and the profits ought to be larger in proportion.

Crop Failures.—"Hold on!" I hear the reader say, "do you not allow for crop failures in this estimate of yours?"

One has occasionally a poor year in corn growing. A crop failure in corn grown on well drained, well enriched land, on alfalfa sod, has yet to be recorded. A crop failure with alfalfa has not yet been recorded. Certainly some years produce more than other years. Alfalfa is the safest and surest of all crops when established on kindly soil. The risk is very slight, only one has always the labor of harvest, not the labor of preparing the land each year, of eternally seeding.

Saving of Labor Cost in Alfalfa Growing.—Note in this example that on the 320-acre farm only 80 acres are plowed each year for corn, and 40 acres more plowed and sowed to alfalfa, only 120 acres of plowing in all. The rest of the land needs neither plowing nor planting; 60 acres of it in permanent pasture, 120 acres of it in alfalfa, already sown, already set, needing only the sun and showers to leap into joyful harvest. The saving of labor is tremendous on an alfalfa farm rightly managed.

A Shorter Rotation.—One can use this rotation with corn and alfalfa; Corn one year, wheat one year, the stubble plowed and sown to alfalfa, alfalfa two years, then corn again. This takes four fields and is in many ways a good rotation, and a labor saver, too. How would it figure out on a 300-acre farm?

Sixty acres are devoted to corn and as this is always on alfalfa sod and must also have manure, we can not well escape a yield of 90 bushels per acre, or anyway 5,000 bushels. Corn stubble well prepared is a good place for wheat. The 60 acres of wheat then we will say produces 25 bushels per acre, or 1,500 bushels. The wheat stubble is plowed instantly when the wheat is harvested and sown to alfalfa which is mown for two years. This gives 120 acres in alfalfa each year which will produce 480 or 500 tons of hay. Then there are 60 acres of pasture, orchard and woodlot, as in the preceding example. Summing this up we have 5,000 bushels of corn, and selling 4,000 bushels at 50 cents gives $2,000. The

1,500 bushels of wheat may bring $1 per bushel and may not; call it that and we have $1,500. By utilizing the corn stover the alfalfa hay could mostly be sold; say we sell 400 tons of it at $8, we have $3,200. Adding up we have gross sales in this instance of $6,700. The thing works out about the same. In some ways this is the better rotation. For one thing corn following corn, even for two years, suffers somewhat from insects. In this rotation corn is almost absolutely sure as it is always on alfalfa sod and is manured as well. It should never yield less than 100 bushels per acre under such treatment.

Work for this Rotation.—In this rotation one finds this amount of work to do each year: 60 acres of alfalfa sod to break. This should be mown off four times as the late mowing for some reason makes the roots easier to break. One good three-horse team of heavy horses will break the 60 acres, taking it in a leisurely fashion from October till spring, whenever there is open weather. Alfalfa sod fits easily for corn. The wheat is sown in the clean corn stubble by simply disking and drilling in. It should have additional phosphorus to start it vigorously off before cold weather. The wheat stubble should be plowed very swiftly after the wheat is taken off, and here is the worst feature of this scheme; at the same time one may need teams in the corn field and in the alfalfa meadow. It may be necessary to arrange to hire additional teams at this time to get this seeding well and promptly done. It will greatly help if the wheat stubble is thoroughly disked the mo-

ment the wheat is cut and shocked; this will conserve moisture and make the plowing easier. Or on some soils and in some climates the disking alone will be all that is needed for alfalfa seeding, so it is very thorough. And again there are places where when the land is once well inoculated with bacteria alfalfa may be sown in the wheat in the spring with first rate stands resulting. If this is done the seed should not be sown early; the land should get dry enough to harrow and in April should be thoroughly harrowed, not enough to destroy the wheat, but enough to make a good seedbed, and the seed sown and dragged in. This often increases the yield of wheat and is pretty sure to result in a good stand of alfalfa. It is not safe to try this method of seeding except where wheat stands up well and where the land is thoroughly well inoculated with bacteria.

What Is Alfalfa Land Worth?—Carrying these two examples to their conclusion, what is good alfalfa producing land in the cornbelt of America worth as an investment?

Everything depends upon the management. Here is an estimate of the cost of carrying on this farm:

EXPENSES.

Labor of 4 men for a year	$1,600
Interest on and deterioration in farm teams	500
Extra labor in harvest, threshing bill	400
Depreciation in machinery, repairs, fertilizer	400
Taxes and repair of fences	500
Total	$3,400

INCOME.

From sales of corn, wheat and alfalfa	$6,700
From colts, pigs, poultry, veals, (pasture)	300
Total	$7,000
Less expense.	3,400
Net income	$3,600

This is 6% interest on $60,000. Thus the land yields return on a valuation of $200 per acre.

Are these fanciful figures? Not at all, but plain matter of fact business. And while we are estimating profits by sale of hay and grain, we do this only because it is the easily-done thing, urging all along that the hay and grain be fed on the farm and the manure returned to the land, when net profits will often be much greater than indicated above.

Such Profits in Actual Practice.—And are there many farms now ready to yield corn and alfalfa in this fashion? No. Most farms need thorough under-draining first. Hardly any of Illinois is well enough drained for alfalfa, neither is much of Indiana or Ohio. Iowa has more dry land, perhaps. Nearly any farm that a man might choose to make into an alfalfa and corn farm would need much work before he could safely expect any such returns. He can find an acre, or a field that is all right; let him then determine that ere he is through with the thing it will all of it be good enough. Make it a legacy to the children to leave them a farm so well under-drained, so well limed, if lime is needed, so fertile that they can realize these results. It is easy; there is no step to be found out; the way is clear and plain and the land will pay for the work as you go on.

Rotation in the Dairy Region.—In northern Ohio, Illinois, Wisconsin and New York dairying is a great business. Here alfalfa is especially desirable and so is silage corn. Here also potatoes thrive and are

profitable. Let us see what sort of rotation is adapted to this region.

A considerable amount of land will naturally be devoted to permanent pasture. Supposing we take 160 acres of land to be put under the plow. We will begin with a field of potatoes, 40 acres, planted early, thoroughly well cultivated, dug early and marketed, say 200 bushels per acre. This is 8,000 bushels at 50 cents, or $4,000. Alfalfa is sown after the potatoes. This remains two years after the first year, thus 80 acres will be mown, or 320 tons of hay. Forty acres will be turned under each year for corn, part for the silo, part for the crib. On the alfalfa sod the corn will need no manure; this may all be applied to the corn stubble and the land planted to potatoes and thus back again to alfalfa.

How Many Cows?—Fifty cows will consume in six months about 100 tons of alfalfa hay. Letting them have a ration of it, as is wise, at milking time during summer, spring and fall they will get away easily with 150 tons. Horses will take a lot more and there will evidently be a surplus unless some good heifers are raised. Fifty cows will consume 200 tons of silage in six months. That will take the corn from 20 acres or less of the 40 devoted to it and leave approximately 20 acres to be ripened and put in crib.

Profit from the Cows.—As to the profit of keeping the 50 cows I prefer to let the experienced dairyman make the estimate. There are cows that yield as much as $125 in a year, and even much more than that, and others that drop far below $100. It is safe

to leave the question with the dairyman, merely pointing out to him that with corn and alfalfa he needs buy no protein; all that the old cow gives him will be his and will come from his own soil. And steadily, if he cares for the manure, will his farm improve in fertility.

The Labor Cost.—The labor cost of this farm will not be very heavy, aside from the dairy work. Forty acres of alfalfa sod will be plowed each year for corn, 40 acres sown to alfalfa after potatoes; the rest of tillage work will be simple and easily managed. Should more than 50 cows be kept more of the corn will be made into silage, which may cause a need of some dry grain not produced on the farm, mainly for horse feeding.

YIELD OF ALFALFA.

I desire to raise no hopes in the reader's mind that can not be realized and I have thus sought to be moderate in my estimates of what alfalfa would yield per acre. It is a most interesting question to study, the possible yield of alfalfa in various soils. In California, with a very long growing season, we are assured that as much as 12 tons of dry hay has been harvested per acre. This of course was done by irrigation in a soil peculiarly well fitted to alfalfa growing. It may fairly be taken as the extreme limit of possibilities. There are alfalfa fields that because of unfitness of soil, do not yield more than one or two tons per acre. What then, ought we to get?

Moisture the Limiting Factor.—Given plant food in the soil and proper bacterial relations alfalfa ought to grow about as well in one place as in another. The limiting factor in almost all crop production is water. Alfalfa usually does not have moisture enough to make a maximum crop. Even on wet soils, and chiefly on undrained soils, it does not have water enough. That is because its roots do not work in undrained soils so it must forage only on the surface. All plants drink their food; they do not eat as animals do. Given water enough in a deep pervious soil that the roots can use, and plant food, alfalfa will do its best.

There is hardly any other plant that will so thoroughly pump the moisture out of soils as alfalfa. Its roots reach down deep, its leaves transpire a vast amount of water every day. For that reason alfalfa is not usually very beneficial to a young orchard, as it dries out the land too much. The writer has seen a thick stand of Kentucky blue grass so dried out by the alfalfa growing with it (the grass an intruder) that it killed it out, root and branch. This of course is most unusual; as a rule the grass lives long enough to choke the alfalfa.

Amount of Water Used.—Unfortunately no one has determined the amount of moisture used by alfalfa in making a pound of dry matter. Taking the red clover plant as a guide we may assume that it requires from 400 to 500 pounds of water for each pound of dry matter made. Guessing that it takes 450 pounds of water to make one pound of dry matter we reach the conclusion that to grow six tons of alfalfa hay will require about 2,500 tons of water. That is equivalent to about 25 inches of rainfall, if none of it were lost. There is beside a considerable loss by evaporation from the soil. To balance that we know that we have a store of subsoil moisture gathered during the winter and early spring rains.

Now, the rainfall during the 18 weeks that alfalfa makes its hay crops (in the cornbelt region) is seldom more than 18 inches and is often very much less than that. So it is clear that lack of moisture is often the limiting factor in alfalfa growing. For that reason the writer, while he has grown six tons

IN YOUNG ALFALFA UP TO THE HUB.

on one acre on Woodland Farm repeatedly and has known of much heavier yields elsewhere, has not estimated that even good alfalfa would yield more than five tons to the acre, and in fact advises growers to be grateful if they get four tons—grateful, but not satisfied, as they should begin at once to consider in what way they can bring up their average yield.

It is unfair to the alfalfa plant to assume that it has no greater producing power than red clover, given the same amount of moisture. It probably makes much better use of its water than does red clover. And some varieties of alfalfa can do more with a given amount of water than can other varieties. Unfortunately we do not yet find any variety specially adapted to dry soils and hot climates that is at home in a rainy land or will do as much there as common alfalfa.

Increasing Water-Holding Capacity.—In what way can the water-holding capacity of the land be increased? By deep draining, first, since that lets the alfalfa roots feed down deep. By deep plowing next. By use of the subsoil plow. The latter is in many soils a very potent factor in increasing the yield of alfalfa in dry years.

Yields Under Irrigation.—In irrigated regions rainfall is of course not a limiting factor. There soil fertility, length of season and systems of management control the yield very largely. I feel certain that I have grown nearly 10 tons of dry alfalfa hay per acre on good land in a valley of Utah, under

a very hot sun, with abundant water and a long growing season. The practice was to flood the land immediately before mowing off the crop; this made the alfalfa start vigorously into new growth as soon as it was raked off. In a week another flooding was given, the earth taking all the water it could absorb. As this land was beautifully drained by being underlaid with sand and gravel of great depth and no underlying moisture it never suffered from too much moisture; thus growth was extremely rapid.

Furthermore, in that arid region the subsoil is quite as fertile as the top soil. There is little difference in texture or soil content whether one takes soil from the surface or from a depth of 20 feet or more, and doubtless the alfalfa roots penetrated quite 20 feet in that soil.

I. D. O'Donnell once pointed out to the writer near Billings, Mont., an irrigated farm of exactly 160 acres, all in alfalfa except a small lot around the house and barn, maybe two acres in all, and from which he had bought the hay one year. It amounted to fully 1,000 tons, or a little more than six tons per acre.

Irrigation is impractical under eastern farm conditions, as a rule. There are farms, however, near the mountains, in what might be called the Piedmont sections of New York, Pennsylvania, Maryland, Virginia and the Carolinas, where irrigation would be quite easily arranged and some day this will be done. Irrigation would pay richly in the East as well as in the West. It is much practiced in humid Eng-

land, in France, Italy and other lands where farming is carried to a high pitch of perfection. Irrigation of alfalfa is only practicable where soils are permeable so that any excess of moisture will readily sink away, or else are thoroughly well underdrained.

Poverty of Soil a Factor.—After all the most frequent limiting factor in alfalfa production in the eastern states is soil fertility. There is not enough phosphorus in the land, or it lacks humus and bacteria, or it lacks abundant carbonate of lime. On Woodland Farm I once applied phosphorus to an alfalfa meadow set about three years, using acid phosphate at the rate of about 250 pounds per acre. Strips were left with no phosphate to test the effect. Where additional phosphorus was given the land the yield of hay was nearly doubled. Thus about $2 worth of fertilizer made a growth of about two tons of hay per acre. This astonishing profit from the use of phosphorus on alfalfa was the beginning of regular use of phosphate fertilizers on new meadows and old on Woodland Farm.

The plain truth seems to be that along the 40th parallel, in the region of the corn belt we ought to mow at least four tons of alfalfa hay per acre and could, by making our soils right, get six tons with favoring seasons.

DISKING AND CULTIVATING.

In some regions it is a practice to disk alfalfa once or more each year. In Kansas and Oklahoma it is often practiced to disk once in the spring and again after each cutting as soon as the hay can be removed from the ground. It is believed that disking conserves much moisture and otherwise promotes the growth of the alfalfa. It has often been asserted that the disking splits the crowns and thus thickens up the stand. This is as though one were to split down the tree trunks in his orchard "to thicken the stand." The splitting of alfalfa crowns can do nothing but harm and often starts a decay of root that ends in the death of the plant. However, the result of disking is often beneficial when done in early spring, before growth sets in. It certainly deters weed and grass growth and lets air and water into the soil. Later diskings help in some regions and soils and do mischief in others. The main beneficial effect of disking is the conservation of moisture and destruction of weeds or grasses.

In Louisiana disking alfalfa seems beneficial on the whole. In Kansas it is much practiced and some think it very helpful, while others declare that excessive disking materially reduces the yield. On Woodland Farm disking when fertilizer was sown at the same time has done wonders; disking alone has in some instances decreased the yield.

Disk with Care.—Disking of alfalfa must be done with care and discrimination. If alfalfa roots are cut off by a disk harrow or any other instrument the plant dies. Old and tough roots are not in much danger of being cut off. Young alfalfa, with more slender roots, is easily enough injured or killed. Thus the disks should not be sharp as knife edges and should be set straight enough not to cut off the crowns. It is well for the owner of the field to drive the disk. Dig up the land as thoroughly as you please, but do not cut off many crowns. One may disk and immediately cross-disk in early spring, burying up the alfalfa crowns somewhat, and no harm will result as they will come through pretty soon. After this disking I think it much of a local question whether one should disk more or not. If blue grass has run in, or any perennial grass, it may be wise to dig it out or it may be wiser to turn it all under, plant corn, then re-seed.

Prevention of Grass Best.—As a matter of fact, a dollar spent in buying carbonate of lime and phosphorus, with drainage, will do more toward keeping weeds and grass out of alfalfa than two dollars worth of labor spent in disking. Where plantains come and weedy growths the soil is wrong; remedy that and the alfalfa will smother all else. Where crab grass troubles, as it does in the South, an abundant supply of carbonate of lime in the soil will make the alfalfa too much for it, unless perhaps it may come very late in the season, when it is not worth noticing.

The Alfalfa Harrow.—There is a special alfalfa harrow made like a disk harrow only with circles of sharp spikes that are supposed to penetrate the ground and loosen it, throwing out the grass roots without injuring the alfalfa. The theory of this implement is good but in practice it does not work so well. There is difficulty in getting it to penetrate deeply and if it throws out grass it is speedily wound up on the axle so that I am not at all certain that the machine will supersede the ordinary disk harrow.

The Spring Tooth Harrow.—Where Kentucky bluegrass is coming in, or bermuda or other grasses, after all the best thing probably to rake them out is the spring toothed harrow. One needs a strong harrow, not too wide, and weighted well, when if the alfalfa is well established and strongly rooted it will be relieved of its encumbering grasses without being materially harmed itself. Or the spring tooth harrow may be used after the disk harrow.

A Deep Tilling Machine.—The Spalding deep tilling machine is the invention of a Californian and was first used there in plowing heavy adobe soils. It is essentially a very large and strong disk plow having two 24″ disks set to run in the one furrow. With this plow one can readily plow 12″ to 16″ deep. The forward disk throws down the upper surface soil, with its trash and weed seeds. The following disk throws over this top earth 8″ of the subsoil, bringing up earth free from weed seeds. All the soil turned is very efficiently pulverized. In certain soils

where the subsoil is well stored with lime and the top soil somewhat lime-hungry this machine will do incalculable good. It is probable that in almost any soil meant to be devoted to alfalfa this machine will very greatly increase the yield. It is easy to get a stand in the clean earth thrown up from below. The deep stirring, the aeration, the reservoir for moisture all help make the land fit for alfalfa. To deepen suddenly the plow furrow to 16″ might on many soils be injurious to corn, but it could hardly be anything but helpful to alfalfa and corn after the alfalfa would reap the benefit.

The three good purposes secured by use of this machine are first, the loosening and aeration of the soil, next the turning up of a fresh and unexhausted supply of carbonate of lime (which would not be found in all subsoils), and third, the making of a clean seedbed of fresh earth from the subsoil and the burying deep down of weed and grass seeds.

WEEDS AND GRASSES.

Much ado is made over the fact that in some regions weeds and grasses trouble alfalfa. It has been proposed to plant it in rows and cultivate it in order to subdue these intruders; indeed, this very thing is practiced in some regions. In alfalfa growing sections little thought is given to the question of weeds or grasses in the fields. The alfalfa seems able to subdue almost every intruder. There are a few exceptions; some weeds persevere in even good alfalfa soils. It is true, however, that when the soil is made right and a good stand of alfalfa secured one need give weeds little thought. It is ten times better to spend effort making soil conditions right than to spend it in fighting weeds.

Some Troublesome Weeds.—Some of the weeds that trouble in certain sections and not in others are crab grass (an annual grass), wild cress, chickweed, (an annual that makes most of its growth in winter), lamb's quarter, pigweed and ragweed. Crab grass and sheep sorrel seem never to trouble alfalfa seriously when the land is full of carbonate of lime. Not that the lime kills the crab grass, but when there is lime enough in the land with fertility, the alfalfa is so vigorous as to distance and smother the crab grass. Cress comes only in winter and usually makes no trouble except in fall-sown alfalfa when it may injure the first cutting if intended for market.

Afterward, if the soil is right, it will not be seen. Chickweed is not a serious disturbance to alfalfa and when present may be harrowed out with a spike-toothed harrow in early spring. Lamb's quarter succumbs to mowing, as does pigweed, both being annuals. The same is true of ragweed, which totally disappears from a field with soil made right and sown to alfalfa. Sheep sorrel, that vile pest of old eastern farms, disappears the instant alfalfa is sown among it on land filled with carbonate of lime and made rich. So disappears that pest ox-eye daisy; nothing is surer to take it out than alfalfa, if the soil is made right. Wild carrot is out when alfalfa comes, and the Canada thistle retreats, to be seen no more.

The terror of many eastern farms is found in sheep sorrel, wild carrot, daisy and Canada thistles. If alfalfa would do no more than to exterminate them it would be richly worth while. Very great effort is yearly expended in fighting these weeds. If a little more effort was put with that already spent, and wasted, in unavailing conflict, in the way of putting the soil right, making it dry, filling it with carbonate of lime, filling it with humus, giving it phosphorus and then alfalfa seed, the battle would be won, the weeds exterminated and at no cost at all, as the alfalfa alone would far more than repay the farmer for all his effort and expense.

There are other weeds that are exceedingly troublesome that alfalfa causes to disappear. The bindweed or morning-glory, sometimes called wild

sweet potato, an exceedingly troublesome pest in corn fields in the Middle States, is exterminated almost completely when the land is put into alfalfa. So of many other troublesome things that might be mentioned.

Weeds that Kill Alfalfa.—There are weeds, however, that get the best of the alfalfa. Quack or couch grass is one of these. This grass fills the soil with a dense mat of roots, each one a burrowing, creeping underground stem armed with a sharp point. Wherever it gets a good foothold it is usually too much for the alfalfa and I am unable to outline any good and easy system of destroying it. When it first appears upon the farm it should be fought and exterminated before it gets much foothold. It is possible that alfalfa could be sown in the fall and so stimulated with phosphorus that it would start very vigorously in spring and thus get ahead of the grass and smother it out. It is well worth experiment at any event. And it may be that by vigorous use of the disk harrow, followed with the spring tooth harrow the roots could be so disturbed that they would give it up, and the alfalfa yet remain practically unhurt.

Kentucky blue grass is another grass that is too much for alfalfa. It creeps in and thickens up till after a time the alfalfa is seriously weakened. It is hardly worth while to fight so good a thing as blue grass though it can be torn out with a spring-tooth harrow. Blue grass does not usually come in before three or four years, and by that time it is well to

plow the alfalfa in regular course of rotation any way. Later on I will tell of what good may come of using blue grass and alfalfa together.

Plantains are a serious annoyance in alfalfa fields. Drain the land where they appear, enrich, and if need be lime, re-sow and plantains will be a thing of the past. Canada thistles have been mentioned; alfalfa is the best known eradicator of these.

Sweet clover is often mentioned as a weed in alfalfa fields. It is usually introduced through the presence of sweet clover seeds in the alfalfa seed. Often the unfortunate seedsman is blamed for this. Sweet clover is not often intentionally added to alfalfa seed. Sometimes, in fact, melilotus seed sells higher than alfalfa seed. The seeds are nearly exactly alike; only an expert can tell them apart, and no machine in the world would separate them. The sweet clover seeds get in when the alfalfa seed is harvested, through accidental admixture in the western fields, where it quite frequently grows along the edges of the fields. A seedsman who is quite careful to get the best western seed is very likely to sell a small amount of sweet clover seed, quite against his desire.

Sweet clover in the alfalfa, however, is not at all a serious pest. At first it makes its bravest showing; the frequent mowings cause it to disappear and being a biennial it is soon gone with no harm done.

Russian thistle comes in new seedings of alfalfa from western sources. This promptly disappears with mowing. Docks in alfalfa will probably persist

till they are taken out with the spade, though sometimes the frequent mowings exterminate them. Spearmint disappears with cutting.

Foxtail grass is really the vilest weed that comes in alfalfa in the cornbelt region. It is an annual grass that comes up each spring or some time during the summer. It loves an alfalfa sod. Mowing it does not destroy it, and it will seed if no more than an inch high. Fortunately the seeds readily germinate and one can take advantage of this fact to eradicate it practically the year before the alfalfa is sown. If he will put the land to corn or some other cultivated crop and so carefully cultivate all the season that not one head of foxtail grass goes to seed, the thing will be eradicated from that field. It does not seem to have power to carry seeds over in the soil as do so many weeds. They all seem to germinate in one year if lying in the soil or in contact with it, and if the seedlings are destroyed without chance of maturing seed again that weed is eradicated from that field. This has been the experience of the writer and his brother on Woodland Farm, where a 60-acre field once alive with foxtail grass was made clean in one year except some places along the margins where cultivation was not so thorough as it should have been. In order to accomplish this. however, one must go through the field with the hoe at least twice after cultivation has ceased, else there will be estrayed plants maturing seed to become centers of future infection.

Yellow trefoil is a small, low-growing clover with

a small yellow bloom. Its botanical name is Medicago lupulina. It would not be classed as a weed only that it is so often used to adulterate alfalfa seed. It is a cheaper seed than alfalfa and much imported seed is adulterated with this, and some unscrupulous seedsmen bring the seed over especially for purpose of mixing with alfalfa seed. It is a good pasture plant and in Europe is often sown with other clovers to make a good bottom for cattle to bite. It has no especial value with us, but is in no sense dangerous. It is a biennial.

We have reserved the worst for the last. Dodder is the arch enemy of the alfalfa grower. Dodders are parasitic plants that begin life from seeds dropped on the ground, developing slender, nearly leafless twining stalks. These stems wherever they touch plants of their liking send out roots that penetrate the host plant and suck its juices. Afterward the parasite does not again send roots into the soil, but twines from stem to stem of the unfortunate host plant until it is tied together in a tangled mass. Ultimately the host plants are usually destroyed. Dodder has usually bright yellow or orange colored stems, nearly leafless, with very small flowers close to the stems and many seeds. There are dodders that attack various species of plants, including red clover and alfalfa.

Dodder always starts from seed which is found mixed with clover and alfalfa seed. At first there will be a very small spot infected at each center where a seed dropped; later it will be a spot as big

as one's hat, then soon it will be 2′ across, and thus rapidly it spreads till there is a circle of dodder surrounding a devastated and dead center, the circle rapidly enlarging. Prevention is the best remedy, and is easy enough, since by exercising care one can buy alfalfa seed free from dodder. The seeds are not impossible to separate from alfalfa seeds and careful seedsmen do not send out badly infected alfalfa seed. It may be possible, however, with the best intentioned and most careful of seedsmen that an occasional dodder seed will get through. Therefore the grower should be on his guard and nip the threatened evil in the bud as soon as it is seen.

Eradication of dodder is easy if it is taken soon enough. Remembering that as it has no root system of its own it is only necessary to cut down the alfalfa at this spot, cutting close to the ground, leave the stuff lie where it grew and as soon as it is thoroughly dry place an armful of dry straw on it and set on fire. This will usually destroy the thing completely. There will not be any loss worth mentioning. The fire may kill a few alfalfa plants, but it is probable that they will start again from their roots. Under no conditions should the infected patches be raked and the dodder put in with the hay. This distributes seed over the farm, and besides one forgets the exact location and size of the patches if they are raked.

If through buying inferior alfalfa seed one gets a field badly infested with dodder he may find it best to plow it up, grow a cleaning crop for a year, and then re-seed.

It is little less than a crime to cut seed from a dodder-infested field and put it on the market. While it is true that most of the dodder seed can be taken out, yet unfortunately most seedsmen are too careless to do this and thus the pest is widespread and immense damage results.

There is a clover dodder that operates just as does the alfalfa dodder, another one seen on mint, and one on flax. I do not think these dodders able to grow on other plants than the one species they select.

To avoid dodder get samples of alfalfa seed from your dealer and submit them to your experiment station, or to the Department of Agriculture for examination for dodder. If it is present in anything more than an infinitesimal amount inform your dealer and choose seed from another bin. It may not help to choose another seedsman, and then again it may.

ALFALFA DISEASES.

Mention has frequently been made to the appearance of rust on alfalfa leaves. It will appear in almost all parts of the humid states after alfalfa has grown about 40 days. During hot and humid weather it will be worst. On poorly drained soils it will be worse than on dry soils. When alfalfa suffers lack of inoculation it will be worst of all, and incurable till inoculation has been given. There is no cure for the disease unless one can remove the inducing causes. If the land is wet, drain it. If it needs inoculation, attend to that. Lack of lime is an inducing cause. When the soil is fit rust troubles hardly at all. It appears on lower leaves slightly at time when the crop should be cut and made into hay. By the time rust appears again it will be cutting time again. It is worth mention again that too early mowing induces rust.

Alfalfa Root Rot.—Alfalfa roots can not endure submergence in water in warm weather. If the land fills up and stands full of water for a time when the sun is hot the alfalfa will die. If it stands not quite full, but with the subsoil full the roots will decay at the water line. Thus the field will suddenly begin to fail and the owner may wonder why. I have had fields on Woodland fail in this manner when tiles became obstructed and rainfall was excessive. I have observed similar instances in Louisiana and other

states. This is not the true "root rot." It is not contagious; drainage will stop it, but once rotted the field had better be plowed, planted to other crops or resown.

The Cotton Root Rot.—This is a most serious proposition, fortunately not yet widespread. It is found to some extent in Texas, Mexico and some other cotton-growing states. When root rot attacks cotton the plants die in a circle, ever widening. If alfalfa is planted in a field infested with this disease the plants die in similar manner, all dying, usually, leaving a round spot of dead alfalfa.

There is no known available remedy. If a field is badly infected with root rot it should be plowed and devoted to other crops for a time. It is not now known how long the land will remain infected. Land known to be infected with cotton root rot should not be sown to alfalfa.

SEEDING GRASSES.

Usually alfalfa grows best to be alone. There is, strictly speaking, no other plant that matches it very well to be sown with it. Nothing else matures at just the same time or makes so many cuttings as alfalfa. However, there are places where it is well to mix other seeds with it.

Red Clover and Alfalfa.—In some parts of the eastern states red clover is sown with alfalfa, about 5 lbs. of red clover to 15 lbs. of alfalfa per acre. The result is said to be very good. Where the red clover is sown there are heavy crops of the mixture for one year or more after seeding, then when the clover has died out the alfalfa is said to grow with more vigor than on adjoining plots where it was sown alone. I have seen this mixture in use in France and with it some grasses—I think rye grass, orchard grass and perhaps timothy. Certainly the wealth of herbage yielded by this mixed meadow in France was astounding. It was not intended to remain long, being in a scheme of comparatively short rotation.

It has already been mentioned that alfalfa ought at all times to be added to red clover when sown on land that may be suspected of having quality enough to permit its growth

Timothy in Alfalfa.—In some instances when alfalfa is meant for horse feed it is not a bad plan to

sow a small admixture of timothy with it. This may be done in the fall, not at the same time that the alfalfa is sown, but later, in September, when the timothy may be lightly harrowed in. Timothy takes very readily in alfalfa, if sown the first fall or at any later time. When fields are established, if there happen to be any thin places where from wetness of soil or any other cause the alfalfa does not thrive or is not thick enough, timothy may be sown there and will grow well. The first cutting of hay will be a mixture of mainly timothy and alfalfa, the succeeding cuttings will be nearly pure alfalfa. It is astonishing the burden of timothy that will result when alfalfa is mixed with it. Red clover in timothy is usually a detriment, since clover is somewhat dusty for horse feed; alfalfa and timothy make a mixture hard to equal, since the two balance each other.

In cutting this mixture attention should be given to compromising times for cutting the first crop. It will not do to cut the crop when the alfalfa is perfectly ready, since that will be too early for the timothy, nor will it do to wait till the timothy is just right, since that will be too late for the alfalfa. Timothy cut early is far more nutritious and digestible, in any case, than when cut, as it usually is, with seed formed.

Alfalfa and Alsike Clover.—I have seen marvelous fields of mixed alfalfa and alsike clover. This mixture makes especially good pasture. When alfalfa is sown for mowing, or for enduring several years,

it is doubtful if this admixture is good, but when alsike clover is sown for meadow or pasture it is evident that on suitable soils, well drained and sweet, alfalfa makes a good ally. A mixture of equal parts of seed will give a stand of alsike with a lesser proportion of alfalfa plants. Or the mixture may be in proportion of 2 of alfalfa to 1 of alsike clover, which will give a pretty evenly divided meadow. Cattle and pigs love to graze on such a field as this.

Alfalfa and Brome Grass.—Brome grass (Bromus inermis) is a good grass for pasture and in some places makes pretty good meadow. It is a cold-resistant, heat-resistant, drouth-resistant grass, very vigorous on good soil. It makes a dense growth of leaves down close to the earth and the stem or top is not very important, being light and feathery. Animals like brome grass exceedingly well as a pasture grass. The writer knows of no other grass so palatable to sheep and cattle. It is probable that it is the best pasture grass yet introduced into America, where it is adapted to the soil. It likes rich land and when grown alone with no clovers intermixed it seems soon to suffer for nitrogen and falls off greatly in yield of forage. When mixed with alfalfa or red clover it seems to receive fertilization from association with its sister plant and yields very much more heavily.

Brome grass loves to grow in alfalfa. It is probably the best plant to sow with it when the alfalfa is to be grazed with cattle or sheep. Alfalfa is not always a safe pasture for cattle or sheep when sown

unmixed with grasses. In some regions it is almost deadly in it effects. It causes bloat or hoven. In other regions it seems a safe enough pasture. It is very noticeable, however, that where it is safe pasturage there is usually found a considerable admixture of grasses with the alfalfa. Animals grazing alfalfa get a superabundance of protein in their diet. This makes them long for some grass or other carbonaceous diet. When grasses are mixed with alfalfa the animals will eat alternately of each. Thus a more healthful ration is compounded by the very instincts of the animals.

In using an alfalfa pasture that had in it a considerable admixture of brome grass I never had a serious case of bloating with either cattle or sheep. On other alfalfa pastures with no grass I had more or less trouble and some loss from death. Furthermore, I saw very remarkable results in growth and fattening of animals grazing these plants, better than I had ever seen on any other pastures in the world, considering the areas of land used.

Brome grass is not broom sedge, as some southern readers might infer; it is a grass coming to us from eastern Europe.

Brome grass thickens up fast by underground stems or roots, very much as Kentucky bluegrass does. A thin stand of it soon becomes a thick stand if the soil is fit. It ultimately crowds out alfalfa, yet for a few years they grow well together and make an immense amount of grazing. All animals relish it exceedingly. Even Kentucky bluegrass is

untouched if brome grass is available. For that reason it does not thrive when sown in mixed pastures with other grasses. So far as I know there is no other grass that animals will eat as readily as they will brome grass.

Seed of brome grass is often seriously adulterated and of low germinating quality. Fresh seed grows well. Seed may be grown in any northern or middle state; it seeds right heavily. The usual sources of good seed are the Dakotas. Brome grass seed ought to be sown in the spring. To get it in an alfalfa pasture one can either sow with the alfalfa if that is spring sown, or he can harrow the fall sown alfalfa in April or earlier and sow the brome seed then. If it is a thin stand at first no matter; it will presently thicken up. It must be sown by hand, broadcast. Twenty pounds of seed is enough for an acre when used as a partner with alfalfa.

Brome Grass as a Pasture Grass.—After alfalfa and brome grass have grown together for some years there will remain little else than brome grass. Ultimately the yield of forage will be much decreased because of depletion of soil nitrogen. Then it may be disked vigorously in the spring and more alfalfa seed, or seed of one of the clovers sown in, with a liberal application of phosphorus. The result will be to quadruple the yield of forage. This grass is destined to come into wide use on the better soils of the eastern part of the United States. It is an efficient soil binder and stops erosion. It is a little hard to get out of soils but not especially so.

The writer and his brother have worked with it for more than twelve years with no especial difficulty in its eradication when the land was plowed and planted to corn and well cultivated.

Winter Grain in Alfalfa Fields.—J. M. Westgate, of the Department of Agriculture, is sponsor for the subjoined:

In the Southwest the mild winters and the occurrence of much of the rainfall during the colder months make it possible to seed wheat or barley in a stand of alfalfa after the last cutting and harvest it at the proper stage for hay the next spring with the first cutting of alfalfa. The presence of a crop of small grain during the winter months prevents the growth of troublesome weeds, which sometimes almost ruin the first cutting of alfalfa. This practice has the further advantage of giving a mixed crop of alfalfa and grain hay, which is regarded as superior to pure alfalfa, owing to the scarcity in that section of feeds rich in carbohydrates or starchy matter. This method is also commendable when for any reason the stand has become thin, as through the action of field mice. The amount of grain to be seeded and disked in depends on the thickness of the stand of alfalfa. This practice has been followed for many years in certain parts of the Southwest, although its value does not appear to be recognized to the extent that it apparently deserves.

Alfalfa and Kentucky Bluegrass.—Kentucky bluegrass (Poa pratensis) loves alfalfa exceedingly well. When soil is made right for alfalfa, it is just right for bluegrass. Both love lime, both love fertile soils, both love well-drained soils. Alfalfa also fills the land with nitrogen, thus the bluegrass crowds in. Usually it is classed as a weed. In a meadow devoted only to mowing it is a hindrance, though it will make a very heavy cutting of hay at the first cutting. The mixture also makes exceedingly good hay, especially for horses or cows.

After bluegrass has run into the alfalfa it makes

wonderful pasture. Perhaps it does not yield as much forage as does the mixture of brome grass and alfalfa, but it is a close second, and bluegrass is indigenous to a large part of our country. Thus it comes in usually of its own accord because of the seed latent in the soil.

Of this mixture Robert Giltner, of Henry Co., Ky., wrote:

I find that alfalfa thrives well with us when we have used enough lime and have sown it on fairly well drained land, made fertile. After a few years the bluegrass comes in thick and I do not know but we get the most profit from it then. It makes the most wonderful pasture that I have ever seen. It is little less than marvelous what fat lambs come from these pastures and how the calves thrive and the colts grazing on it. After the pasture has been used about two years it is nearly all blue grass, thicker and richer than ever seen before on the land. Then we plow it, put it to corn and resow to alfalfa again.

Some men have exploited alfalfa and bluegrass pasture and have made great profit from the use of this mixture of plants. It seems especially desirable as a cattle pasture. Very great gains from such pasture are reported. When it is desired to improve an old bluegrass pasture hardly any better plan could be suggested than to plow it in fall or winter, setting the furrows on edge, harrowing in April and sowing to alfalfa. If the land needs lime it should be given; in fact everything that alfalfa likes should be done and the instructions previously given should be carefully followed in order to get a good stand. The grass will come thinly the first year and thicker the next. The yield of forage will be quadrupled by the addition of the alfalfa and when ultimately the grass has again regained possession of the soil

it will be much more vigorous and productive than before it was plowed.

This is a most practicable scheme that deserves wide application. There is plenty of profit in good pasture. England is a land of grass and grazing; there is found more profit in grazing than in grain growing. The same conditions are rapidly approaching in America. Millions of acres of our best lands will be laid down in permanent pastures because of the failure of the pastures of the West and the advancing prices of beef, mutton and horses. Then should be remembered that the way to stimulate bluegrass is to associate with it a legume, and alfalfa seems the best one for that purpose on the best soils. It is very easy to get a stand of alfalfa on a bluegrass sod. One can plow, disk, sow the seed, harrow and the thing is done, though it will be safer to sow some inoculating soil with the seed and immensely profitable to sow some phosphorus with it as well.

Lime usually helps bluegrass and carbonate of lime or unburned ground limestone is the best sort of lime to choose when it is to be had.

Alfalfa and Orchard Grass.—Orchard grass grows well with alfalfa and the mixture of the two makes much forage and good hay. It is not so palatable a grass as brome grass, but is easily established and really its forage is better than men believe. When using orchard grass pasture animals should not at the same time have run of a pasture of a different grass; then they will eat the orchard grass very

well. The taste of alfalfa gives them more appetite for orchard grass too. Orchard grass does not run and thicken up as does Kentucky bluegrass and brome grass and will not so soon crowd out the alfalfa.

English bluegrass (Festuca elaitor) is the tall fescue grass growing from 2 to 4 feet high, and is a nutritious grass, and animals like it. It mixes admirably with alfalfa when it is to be grazed. It does not spread rapidly and in fact is not in its prime for several years after sowing. It thrives on the dry prairie lands of Kansas and Nebraska. It may be that there is no better grass for mixing with alfalfa than this. It has no bad qualities that the writer has seen.

GROWING BY IRRIGATION.

Alfalfa is a desert plant and thrives best when under desert conditions—dry, clear air, plenty of sun and much moisture applied by means of irrigation water. All the greatest alfalfa growing regions in the world are irrigated countries. The great civilizations of the world first grew up in arid regions where men must irrigate or perish. It is a curious fact that civilization, and especially organized communal civilization, did not first spring up in rainy lands, where one would think that life would be easiest, but in the dry, burning, half-desert lands, such as Persia, Babylonia, Egypt, and in our own land in Arizona and New Mexico and Colorado. In these old dry lands where men must toil to make dams and canals, to distribute water and rescue plants from death by thirst, there grew up cities and civilizations pertaining to cities; there stood the farm house of sun-dried bricks, alike in Babylon and in Arizona; there stood the communal mass of dwellings, the palaces; there developed written language, priesthood, civic conscience, communal spirit and the genius of organization that brought to its present-day development has girded the world with steel bands, built great cities, canals, railways, steamships and all the modern machinery of a complex life of civilization. The forest-dwelling man in a land where it rained seemed to have things all his own way. He dwelt

apart from his fellow men, he learned independence, nor ever developed much of the spirit of interdependence that came with the man living where irrigation was practiced.

After all, in the long run, the forest-dweller overthrew the civilizations developed by irrigation, and now in the marvelous shifting of peoples of these frantic days we find Dane and Norwegian, Scot and Yankee, all jostling each other in the arid West, learning the ancient and honorable art of guiding water over a thirsty land, learning to redeem deserts, to replace sage brush with alfalfa, cactus flowers with roses; to make grapes grow where thorns were yesterday.

Fertility of Irrigated Lands.—Irrigated lands have all the advantages after all, for they are so fertile. Lands where rain falls have been leached for centuries of their lime, of their potash, of their phosphorus. Desert lands have all their mineral wealth yet untouched. No matter if they look gray and infertile, just moisten them, sow the seed, and watch the miracle unfold. Soon overspreads the arid dusty plain a tender green. Little shining streams course between furrows, the hard clods melt, the earth gives up of its treasures, the green deepens, thickens. A meadow has come; it blooms, bees hum, butterflies play in the sunlight, humming birds seek the nectar of the bloom, along the cool depths of the placid canal trees spring up, a little house is soon hidden with fruit trees, alfalfa stacks hide the corral, the desert is forgotten.

Irrigation is the modern miracle of the West and Southwest. It has built railways and towns and cities and states. And the first thing to follow the irrigator's shovel is the alfalfa plant.

Alfalfa Loves Desert Soils.—Alfalfa loves new desert soils. They are not always fertile to the touch of wheat or maize or potatoes. Sometimes indeed they spurn such things and the poor settler would be in sorry plight were it not for alfalfa. Nearly all desert soils love alfalfa. After it has grown for a time, then will grow grain or beets or vines or orchards or any other good things.

The only desert soils that refuse to grow alfalfa are those that have in them too much of a good thing, too much alkali—that is, too much of sulphate of soda, carbonate of soda and other salts. Even these soils can be brought into alfalfa by right management. Drainage with tiles laid deep under the ground will drain off the excess of alkalies; sometimes they can be freed of injurious excess by flooding over the surface and dissolving and washing away the excess of alkalies that have risen to the surface by the evaporation of the soil water.

It is simply marvelous what desert land will do after alfalfa has grown on it. The writer has seen potatoes grown after alfalfa in the valleys of Utah yielding as much as 1,000 bushels per acre. Wheat on alfalfa sod in the San Luis valley of Colorado has yielded more than 100 bushels per acre.

Alfalfa in Arid Agriculture.—Alfalfa is the foundation stone of all the agriculture of the arid

West. Alfalfa hay feeds the teams, the stock mares and foals, the family cow, the calves, pigs, bees, poultry. In Utah at one time half the Mormon population in certain southern valleys was saved from starvation by the use of alfalfa greens in early spring, before gardens could be grown, and after a season of grasshoppers the year previous. The writer can testify that alfalfa greens are good; nothing is any better, cooked as one cooks spinach, taken when fresh and tender and growing rapidly.

Starting Alfalfa by Irrigation.—There are various soils in the irrigated sections and each may need a somewhat different treatment. Soils differ immensely in their physical character and in their slope, and regularity of slope as well. I can not here give all that I know should be given to the subject of irrigation of alfalfa. Alfalfa should be prepared for irrigation in such a way that the water can be put on in large volume, the more the better, so that it will run quickly over the field and then all of it drain away. This can be accomplished in one way on one soil and with one slope, another way on a different soil and on a different slope.

Irrigation by Contour Levees.—There are lands in California so level and irregular in contour that the most practicable system is to flood them all over. To do this long dams or levees are built up, running along contour or level lines. Each levee is so high that when the water is turned in above it fills that part of the field till it has backed up to the foot of the next levee above. Thus it makes a little lake all

over the field. When it has soaked for an hour or day, according to the soil and the season, the gate is opened and all the water not absorbed by the soil is rapidly run off to the check below which is filled in like manner. After this is soaked well the water passes in rotation to the next lower check, or if a number of them are filled at one time passes again into the canal and on down to another field at a lower level.

This is the system of irrigation by contours. It is not a good system when the land has a strong slope, as it is evident that all the levees would have to be very high and very close together, thus the field would be much cut up and of irregular shape. But where there is slight fall, say of 6″ to 100′ and where the land is not of a very smooth surface it is a very good way.

Land may be irrigated very rapidly and at slight expense and labor when once laid out in contour terraces or checks. One laborer can turn the water, no matter how large the volume, into the upper check, may watch it until that has soaked long enough, then may open the way for the water to flow into the next check below. It is the best system when the land is infested with ground squirrels or gophers. They are all forced to leave their burrows and come out where they can be destroyed.

There are a few well-defined principles that ought to be borne in mind in laying out land with these contours for flooding. The contours should not be too far apart, else the dams or levees will need be

too high and strong and the water will be ponded too long in a check. There ought to be no more than about 12″ difference in the levels of the upper and lower sides of these contours. The earth for making the levee should all be taken from below it. This will avoid making the inequality of the land more than it need be. The levees ought to be strong, high, at least 6″ higher than ever needed, and better if 12″, and of easy slope so that the mower can run over each one and thus save what alfalfa may grow thereon and at the same time prevent weeds growing.

There should be large volume of water, so that the checks may be rapidly filled. A small stream will not serve at all since it will put water on the lower parts of the checks long before it will reach the upper sides, and thus one part of the field will get too much water while the other part will get not enough. If only a small stream of water is available the land should be prepared for flooding rather than for ponding, or preferably be irrigated by the furrow method, if the stream is very small.

Irrigation by the Furrow Method.—This is adapted to certain types of soil that soak well. On coarse, sandy or gravelly soils it will not serve, since the water sinks and will not penetrate sideways very far. Nor will it serve well in hard clays, since there it penetrates too slowly. It is in good, loamy soils that the furrow method works best. There furrows 6′ apart, or even at wider distances, will moisten all the land between them. The furrows ought to flow nearly in a direct line down the slope,

since if they run in a direction across the slope there will be danger of their filling and the water fail of reaching the points aimed at. The furrow method will do more with a small amount of water than any other except subirrigation by means of tiles.

The Flooding System.—The most common way of irrigating alfalfa in our West is by flooding. To prepare land for this system one puts in ditches on contour lines, the upper one to bring water to the field, below another to catch the waste water and collect it for the part of the field below.

The distance apart of these head ditches, as they are called, is determined by the nature of the soil, slope and the amount of water to be had. Usually if they are from 400′ to 1,000′ apart it will be well, with an average distance perhaps of about 500′. Much here depends on the nature of the soil. There are soils where it is well to have these ditches as near as 200′ feet or even closer together. Much of course depends upon the head available. If there is not much head the leading ditches should be closer than if there is a flood of water. The ditches while following contour lines rather closely ought to have enough fall so that the water will flow freely in them.

Preparing the Land for Flooding.—The contour ditch is made first, strong, with a good bank. Below it a lesser ditch, close up; this to distribute the water. The field should be leveled as well as possible. Upon this leveling will depend a lot of the later success or failure of the alfalfa. Work in making the land level is work well spent. It should next

be plowed deeply and made mellow. It is then laid off in furrows parallel to each other and spaced according to the soil from 12″ to 2′ or 3′ apart. Various implements are in use for opening these furrows. It is often done with a common plow, making rather shallow furrows as close together as may be necessary, or a special implement with several large shovels affixed to a frame is used; this opens furrows exactly parallel. A roller with ridges turned to fit the furrows sometimes follows these plow shovels and makes very smooth, even furrows down which water may flow very nicely.

The reader may wonder why these furrows are made if the land is to be flooded. It can not be flooded until the alfalfa is well established.

Sowing Alfalfa on Irrigable Land.—The next thing to consider is sowing the seed and getting a stand. Here one may as well forget all that he has known of alfalfa in the East. None of the conditions are the same. In the arid regions one need not trouble to inoculate; as a rule inoculation comes of itself, we do not know how. He can sow in the early spring to good advantage; later the sun is rather hot and irrigation more difficult, though if that can be effected it is as well to sow late as early.

Fertilization is unknown, as the desert soils are rich already in lime, some of them having in them as much as 4 per cent of carbonate of lime, or as much as 75 tons to the acre in the top foot of soil alone. They are also rich in phosphorus, in potash, in nearly everything that alfalfa desires.

In hard alkali clays, however, I found it very useful to mulch the land carefully with a thin layer of manure when starting alfalfa. This shades the land and prevents the forming of an alkaline crust that would destroy the young seedlings. After the alfalfa had become strong enough to shade the land it grew well with numerous irrigations, needing water oftener to keep it thrifty on these clays than on more open sandy soils.

After the land is leveled it is well to soak it thoroughly. This may be done by making temporary furrows which need not be so carefully made as the permanent ones will be. It may be filled with water before it is plowed, and again watered after plowing, if it has much dried out. Then give the final leveling and make the last set of permanent furrows. These furrows should go straight down the slope.

The seed should now be sown broadcast. If sown at once as soon as the furrows are made it is likely that it will need no covering, since the wetting will make the earth crumble enough to cover the seeds. Or if it is a soil that will not crumble the land may be brushed with a brush harrow which will cover the seeds deeply enough.

Next the water is turned in, and here lies all the secret of success after all. Can any man tell another on paper how to irrigate young alfalfa for the first time? If now one can find an old experienced Mormon irrigator he will find him worth nearly his weight in gold.

The First Irrigation.—The principle of the thing

is to turn out a part of the stream in the large cross or head ditch, letting it into the lesser ditch below. This ditch has been carefully opened into each furrow. Now the water is to be carefully divided, so that each furrow will have its share and not a drop more. There is needed the least trickling stream in each furrow. If too much is turned in the land will wash, the seed be carried away, the land spoiled for later irrigations. If too little is turned in it will not reach through the rows. Thus the lower end of the field will make a poor stand. It should be so regulated that in about 24 hours water will be trickling through each row at the lower end and running clear, with no cutting or washing anywhere. In some hot countries it is well to leave the water flow till the plants are germinated and rooted. In other lands to soak well once will suffice to bring the alfalfa up, and it will root and grow for some weeks with the water already stored in the soil.

Nurse Crops in Irrigated Regions.—As a rule it is better to use no nurse crop when sowing alfalfa in the dry country. I have sown with oats, however, and secured a fairly good stand. I have known it to be sown with spring wheat with good results. It is usually better, however, to sow alone.

How Often to Irrigate.—Usually once the alfalfa is up well it is good to let it get somewhat dry before giving the second irrigation. This sends the roots down well and to a degree deters the growth of weeds. The alfalfa ought never to suffer seriously for water before it is given, however.

The second irrigation is much more easily given than the first. More water may be used and there will be less danger of washing. The little alfalfa plants check the flow of the water and distribute it. The land soaks better too. When it needs the third irrigation usually a good deal more water may be turned in with no danger of wasting. Finally when the plants are strong and branched and the crop has been once mown off one may turn a young river over the field with no harm.

The practice then is to turn out all in one place a strong stream, and let it flow till it has reached the cross ditch below, then shutting off the flow at that place to open it a little further along the ditch. It is allowed to flow in at this point till that strip is soaked, when it is again moved farther across the field, and so on till all the land is wet.

These heavy irrigations cause the furrows to level up a great deal, so that a field that seemed rough and ridged for mowing will be all right after being flooded a time or two and one will even wish that he had made his furrows deeper and the ridges more pronounced if he has not his land well leveled. This is the system in almost universal use in our western states.

When to Irrigate.—Alfalfa should never be allowed to get very dry in winter time. It is well to irrigate thoroughly late in the fall, when it will go through winter in good condition. Watering it in winter will not do any harm if the soil is pervious, and any excess of moisture can readily drain away.

In fact winter irrigation is often a very good thing. It saves water, for one thing, that might otherwise be lost for lack of storage, and no one ever heard of there being enough water to satisfy all needs in summer time.

Care must be taken, however, not to let the alfalfa be flooded in cold weather, which might cover over the crowns and freeze into a solid sheet of ice which would destroy the plants entirely. In truth in irrigated regions there is no easier way of destroying alfalfa than to let it be flooded in winter and freeze solid to the ground. This makes it much easier plowing in the spring.

Alfalfa does not want to be too wet when growth starts in spring, since that makes the ground cold and retards growth. One or two waterings will usually be sufficient before the first crop is cut.

It is usually well to water alfalfa shortly before cutting, as this starts off the second crop promptly and vigorously. In irrigated lands one should get the hay off the land as quickly as he can, since growth is usually very prompt and very rapid after cutting. One watering when the crop is about half grown is usually advisable. Here, of course, one must be governed by his soil and water supply, and somewhat by climate as well. There are soils that respond to double the water that other soils require. Loose sandy or gravelly soils will use vast amounts of water, and when this can be given the yield may be splendid.

As a rule the yield of hay is nearly proportioned

to the amount of water available. A yield of 6 tons per acre actually needs 30 inches of water and certainly there will be some loss by evaporation from the surface of the soil and by percolation through into the subsoil. The Utah Agricultural Experiment Station in co-operation with the United States Department of Agriculture made numerous tests of water used, with varying amounts and varying frequency of application. Briefly, it was learned that frequent applications gave much larger returns than infrequent, and that the yield was somewhat directly in proportion to the amount used.

RESULTS OF EXPERIMENTS IN IRRIGATING ALFALFA IN UTAH.

Inches of water applied.	Number of irrigations.	Yield per acre, in tons.
17.058	3	3.125
17.33	4	3.468
24.97	4	5.017
25.002	2	1.55
61.465	12	6.243

Penetration of Roots in Irrigated Soils.—Soils in the arid regions are quite unlike those of humid regions. There is often little difference in physical texture or fertility between the surface soil and subsoil. Furthermore they are usually more permeable than soils in humid regions; both water and air can enter them readily. Thus alfalfa roots penetrate to great depths in such soils. Roots have been traced to a depth of 30′ and even farther. And all down in that soil will be found air, nodules, bacteria; it is a vast factory of nitrogen-gathering, wonderworking plant life. No wonder the "deserts blossom as the rose" when water is applied to them.

Grassing the Ditch Banks.—It is a convenience to

have ditch banks covered with sod. This prevents their washing away from too great heads of water and facilitates irrigation. Brome grass is good for this purpose, or Kentucky bluegrass.

Alfalfa Growing and Irrigation in Mexico.—The following letter from Alf Kessler, once of Utah, now of southern Coahuila, Mexico, is interesting as showing the progress of alfalfa culture in our sister Republic:

When I was very young, in the small seventies, about the first things that happened that made an impression on my mind were the Chicago fire, the killing of Jim Fisk and the planting and growing of alfalfa in Utah (and as everybody knows, Utah was the first territory to be successfully reclaimed by irrigation). I have been in the thick of the conflict from the beginning to the present time, and since I have become grown, have traveled all over the principal western country from Kansas City to the Pacific, and from northern Alberta to Southern Coahuila, Mex., where I am at present engaged in raising alfalfa. I have carefully studied alfalfa conditions wherever I have been and this beats them all for raising the weed, as the natives call it.

First in selecting a locality for raising alfalfa here, be sure that you have plenty of water; then pick land that is on the order of a nice deep sandy loam with not too much alkali; it all has enough lime; then plow it good and deep, level nicely, and be sure it is level to save future trouble, but should have a gentle slope, and sow 16 lbs. of seed per acre broadcast with machine. This we find sufficient. Then we irrigate in the furrow system. To make these furrows we have what we call a drum roller. The drum part is about 36″ high, and with two plows (Center Busters) 26″ apart from center to center, attached just ahead of the roller. It has also two flanges the same distance apart which fit the plow furrow and leaves your small drills or ditches 26″ apart up and down over the whole field. Then we cross-ditch the field and leave these small ditches, or irrigation furrows, 600′ long and you are ready for the water. This takes some patience for the first few irrigations, or until the alfalfa is up about 6″ high and well started all your trouble is at an end. In your first few irrigations be careful and not use too much water, in fact, just as little as will run through

the 600′, and it should come out below clear. If muddy, you are cutting the land somewhere down the line, and losing some of your seed, besides putting the land in bad condition for your mowers. The land should be irrigated until it looks black, which it will with sub-irrigation from one furrow to another; then keep it nice and moist so that the seed will all sprout and come up. If old land is used there may be trouble with weeds, which

IRRIGATING ALFALFA IN MEXICO.

will have to be mown off, and if this is not sufficient, they will have to be pulled out by hand. In irrigating always irrigate enough to keep the leaves wide and a beautiful green color. Should they look a dusty color and a little pinched, they lack water and the alfalfa will soon bud and bloom, perhaps 6″ or 8″ high, where if given sufficient water your alfalfa will grow at the rate of an inch a day, and be ready to cut when about one-fourth or one-half in bloom, about every thirty-five or

forty days after the alfalfa gets into the producing stage. A mistake may be made and too much water given it. In that case it will stop growing, turn yellow and have small brown spots on the leaves. Stop irrigating; cut once in eight or ten days for two or three times; irrigate quickly and not let the water stay on too long and it will come out all right again.

We have about 400 acres in alfalfa here and it is doing fine except where we have dry spells and run short of water. We have had some of the leading men of the Republic here to look at our work, besides Prof. Alfred Burbank of California and others. They all congratulate us on our success, and have no fault to find. In curing the hay, we cut it one day, rake and cock it the next, then leave it in the field to cure a day or two according to the weather. We put it in the stack just a little moist and use a little salt, about 10 lbs. per ton. This keeps it a nice green color, and it holds its leaves when baling. But should the weather be damp or misty, we put it in the stack dry.

These Mexicans all want to irrigate under the contour system, but by so doing they flood the entire surface of the ground, and the sun is so hot here that the land bakes hard so that the young plants cannot come through, or very few of them. Then they want to continue ponding the water, which should always be avoided, for the hot sun soon makes the water warm enough to scald the plants and kill them, or the water stands too long and drowns them, and turns the meadow into grass and weeds and then they say, the peons, "We don't want alfalfa anyway." But people here with energy do want alfalfa, and everything else.

About here this alfalfa will grow 36" in thirty days, and start to bloom nicely if cut at that stage. It can be cut eight or nine times a year, but if let stand a little longer or until it gets a little more firm it will have more food value, and produce more tons of dry hay. By doing this it can be cut easily six times a year, and the plants can rest through the months of December, January and February. In the first instance we cut a little over a ton, and the second about two tons per acre, each cutting. The hay is baled on the ranch. We have an engine and steel press, and the hay is sold in Torreon, Monterey and the different cities and is usually worth about $40 or $50 per ton (silver) by the car load, but recently it brought $75, single ton at Filipinas.

TIME OF CUTTING.

Alfalfa ought to be cut whenever it needs cutting, whether in meadow or pasture. It is the life of alfalfa to cut it now and then. It disappears and is replaced by other plants in eastern soils when not cut occasionally. In the west this is not so true, yet in almost any region alfalfa is healthier and better to be cut now and then.

Time to Cut.—One knows that alfalfa needs cutting when he sees a cessation of growth, an appearance of bloom, a dropping off of the lower leaves and especially when he notes shooting out near the surface of the ground small new sprouts or buds, as though the plant was about to make a new growth. As soon as these shoots appear, cut the crop as promptly as possible. The earlier it is cut after these shoots start the better the hay will be and the more nutritious, also the stronger will be the new growth. Thus the total amount of forage produced by a field of alfalfa is very directly proportioned to the promptness with which it is cut after it is ready.

It has already been pointed out, however, that it is dangerous to mow alfalfa too soon. To cut it before these basal shoots have started may weaken it and in the case of newly-sown alfalfa may also destroy it.

Bloom not a Test.—One can not safely judge of

the fitness for mowing by the state of bloom. Usually when alfalfa is ready to be cut it will be partly in bloom. Sometimes it will be much more advanced in blooming than at other times. Sometimes there will be few blooms showing, and yet a pronounced condition of readiness to be mown off. Whenever it is ready to make new growth, cut it as promptly as you can, regardless of the state of bloom.

It is better, however, to cut it a few days too late than a few days too early, that is, better for the alfalfa.

Late Cutting Damaging.—There is another law that sometimes collides with this: alfalfa ought never to be cut late in the fall anywhere east of the Missouri River. It very seriously weakens it to cut it late in the fall. There ought always to be left a growth of alfalfa at least 12 inches high to serve as protection to the crowns. Therefore it is well to cease cutting by the first week in September, or earlier, according to climatic conditions. It takes some nerve to do this at first. One may leave in the field a ton of hay to the acre sometimes. He will get so much finer alfalfa with so much less death of individual plants in it the next year that he will be glad however.

The First Cutting.—Along the 40th parallel one can cut alfalfa usually about June 1 and find it in prime condition; sometimes it may be cut a week or two earlier. It is essential to get this first cutting

THE MOWER IN A RICH ALFALFA MEADOW.

off as promtly as possible when once it is ready. I. D. O'Donnell, Billings, Mont., is so impressed with this truth that he mows down 400 acres at one clip when it is time to mow it down for the first cutting. As he has little or no rain to trouble him he can do this without fear. Once cut down he hustles to get it off the field as soon as he can. Thus his second crop comes on quickly.

The Second Cutting.—Supposing the first crop to be mown off June 1, the next crop will be ready in about 30 to 36 days. When weather conditions are good it will be ready in 30 days. Say the second crop is taken off July 4, the third crop will be slower to mature because of hot and dry weather; it may come off in 45 days or by Aug. 20. It is probable, however, that if there is a large amount of alfalfa to make into hay one will not find it possible to do it all as promptly as he would like, so that it will be the first of September or a little later when the third cutting is taken off. This will not permit a safe removal of a fourth cutting.

No Universal Rule.—No rule of universal application can be laid down. Almost anywhere in America it can be cut three times. In Ontario it has been cut four times, though it is probable that to cut it three times would be better. There are situations where it will make but two crops, where the altitude is high. In the state of Coahuilla, Mexico, where I was instrumental in establishing a large alfalfa-growing hacienda, it may be cut every 30 days, dur-

ing which time if it has had water enough it will have grown 36 inches. It may there be cut eight or nine times in a year, but even there it is better to cut it only about six times in a year, letting it rest during the months of December, January and February. In that climate on suitable soil the yield is about a ton to each cutting.

Let me repeat with all possible emphasis, in regions where alfalfa is not very strong and is apt to winterkill, do not cut too late in the fall. Leave always a good growth to protect the crowns and to catch snow. Do not graze late in the fall.

Western readers will wonder at this caution. I have had 2,000 cattle on a 90 acre alfalfa meadow most of the winter, coming and going, and have seen no injury in Utah. There the soil was dry, no ice formed on alfalfa crowns and alfalfa was markedly at home. A similar treatment in Ohio would have spelled certain ruin to the alfalfa.

Keep off the Fields in Winter.—Anywhere east of the Missouri River it is very bad practice to go on the fields at all in winter with animals or wagons. Wherever horses tread or wheels go will be lines of dead or dying alfalfa plants. The alfalfa field should be a sacred place after October and until May, no animal should be permitted to set foot within it. No matter just what it is that kills or weakens the plants, the truth is so well proved that it admits of no argument; so let us emphasize the rule never under any avoidable circumstance go

into an alfalfa field with wagon or animals in late fall or winter time. Especially do not let hogs run on the alfalfa in winter.

Winter-killing of Alfalfa.—There are several things that destroy alfalfa in winter time. One is the freezing of ice over the crowns. If this lies close and for some time it will destroy the plants. It is more apt to do this if the alfalfa was late mown. It is not known just why this ice destroys the alfalfa. When snows suddenly melt in Minnesota and Wisconsin, finding the earth hard frozen the water can not sink down and so freezes into a glare of ice that may destroy the alfalfa. In that case it is best to plow, plant to corn or some other crop and re-seed. There is no loss in one sense; it only interferes with a man's rotation.

There is another form of winter-killing, that in clay soils not well drained when the repeated freezings and thawings lift the alfalfa roots out of the soil. This may happen on very good alfalfa land. On Woodland Farm it is a common occurrence for a good deal of alfalfa to be lifted the first winter. If it goes through that it will be too well rooted to be lifted very much the second season.

The remedy is good drainage, deep plowing, and probably subsoiling. These things will take out surface water and also let alfalfa roots penetrate deep enough to be strong enough to escape this lifting.

Spreading with Manure.—There is another thing

that will help and that is to run the manure spreader over the land and cover it lightly with manure. Do not bury it too deep, though alfalfa will in the spring come up through quite a little litter. This mulching should be done in November, though it may be done later if it is not done then. This is the one permissible intrusion into an alfalfa field, to spread lightly over it manure for protection of the crowns. When I say lightly I mean a layer thick enough to cover the land about so that one can not see the earth through the litter. Some men's ideas of a light covering are airy in the extreme. This manure will do no harm in the hay next season. The rain will have washed it clean, it will have lost most of its weight and anyway will have settled down so close to the earth that the rake will not gather very much of it. What is taken up will not damage the hay.

HARVESTING HAY IN THE WEST.

To make alfalfa hay a man needs wide-cut mowers, a supply of rakes, forks and men, then unlimited faith and hopefulness. Especially is this true in the humid East. In the West it is not so much a matter of dodging showers as it is of economizing labor. In the East it is a struggle to get the hay dry enough, in the West a struggle to keep it from getting too dry and thus losing its leaves.

When Ready to Cut.—Before starting the mowers the farmer should get down on his knees in the field and examine the stage of growth of the plants. It is not possible to judge accurately by the state of bloom or any other external sign. He must part the stems and look down close to the earth to see if the little shoots have formed, the shoots that sucker out from the bases of the stems and that are to make new growth. If these shoots, some call them "buds," have not appeared, then one takes risk of injuring his second crop by cutting. He had better as a rule wait a few days. It is hard to explain the injury that sometimes comes to alfalfa when mown off too soon. The succeeding crop may be lessened by half or more if the alfalfa is mown off too early.

Nor can a man delay long after these buds appear without injuring his alfalfa. This injury comes from two sources: for one thing the stems become woody and the leaves are lost; then the

shoots if they get long will be clipped off by the mower and thus growth retarded again. So as soon as these basal shoots appear one should begin cutting. Thus several mowers may be a good thing.

The keynotes of success in making alfalfa hay in the arid West are to mow off promptly when it is time to mow; to rake before the hay is dry enough to lose its leaves; to let it dry somewhat in the windrow and then cock in large cocks, or bunch with the rake if labor is too dear or scarce for hand cocking, and then to hurry it into mow or stack.

Alfalfa leaves are worth about the same as wheat bran, a little more, in truth, and one must struggle always to manage so as to save them; therefore the early raking, and also careful handling afterward.

In the arid West one can bale alfalfa hay right from the fields if he so desires. This he can seldom do in the East.

Curing for the Mow.—A simple test of dryness will seldom lead a man astray. It is to take a wisp of the most moist hay he can find in the windrow or cock and twist it hard as one would make a hay rope, twisting it nearly to the breaking point. If he can see no moisture whatever exude from the stems he may put the hay up, no matter if it is tough. If any visible moisture exudes he had better dry it further else it may mold.

Making Green or Brown Hay.—In the West it is often possible to cure hay that will come from the mow or rick with a lovely green color, as fresh and

green as it had when growing in the field. This color can not often be secured in the East. When hay is so dry before put in mow or stack that it does not heat nor steam the green color will be preserved. In order to have this in its perfection the hay should not be cured altogether in the sunlight, nor ever exposed to dew or rain, but should be cured in part in the swath, raked before the leaves crumble, cured somewhat in the windrow (side delivery rakes are best for this purpose) and the curing process finished in the cock.

This green hay has a distinct market value. There is a demand for it for horse feed; it has no mold on it, has not been heated, is not dusty and is no doubt the best that could be found for horses. It is in favor among eastern dairymen because they consider it the real alfalfa. It is really no better for cows than the brown alfalfa, but it often outsells it in the market.

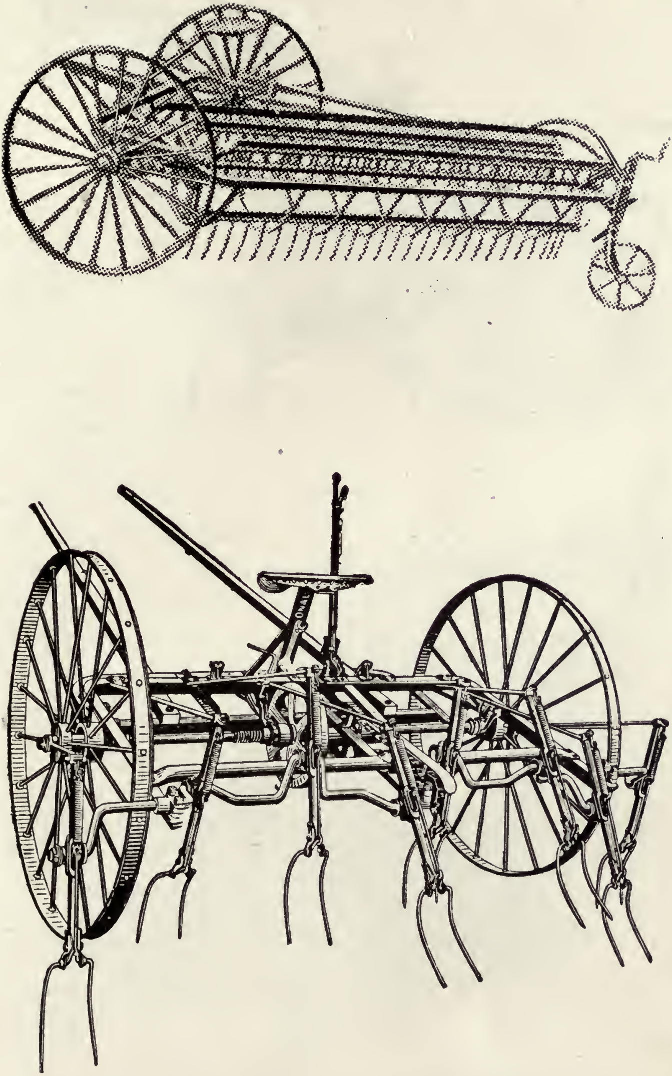
For making into alfalfa meal the green alfalfa is far better than the brown, because it looks better in the bag and is recognized in the market as being the true alfalfa meal. Thus it is made up into cow feed and poultry feed by grinding and perhaps mixing in some other ingredient.

Also, and this may seem like a jest, green alfalfa hay ground into very fine meal has been used to make into bread, sweetcake and muffins for classes of college boys. They have eaten of it and declared it good, have subsisted upon it and done athletic feats.

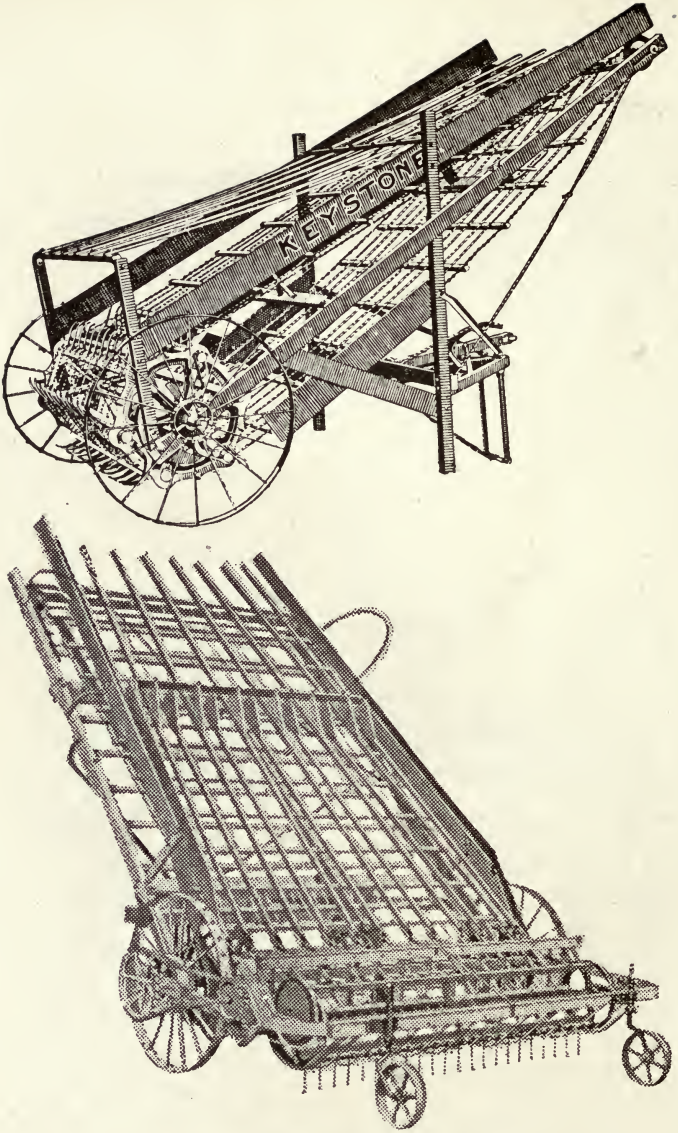
HAYING TOOLS.

The helps of the western man who makes much alfalfa hay are the wide-cut mowers, the side delivery and wide two-horse rakes, the sweep rakes that gather the hay together and carry it with no handling to the stack or mow and the big forks or slings that by the aid of derricks or pitchers lift the hay to the stack top or put it in the barn with no fork handling whatever till it comes to hand of the man in the mow, or the stackers on the stack.

The Side Delivery Rake.—This is a tool not in universal use as yet. It has indeed its limitations and imperfections. It is slower to gather the hay than the wide two-horse sulky rake. It is more complicated, so more apt to get out of order. It costs more. On the other hand it can do many good things that the common rake cannot do at all. It can single out and rake the driest hay, and can turn it up loosely so that air can penetrate it and yet further dry it. It can be used to turn these windrows over if need be to dry them further. Hay may be cocked after the side delivery rake to good effect, or it may be taken up with the hay loader. On the whole, the writer does not see how a farmer making much alfalfa hay can avoid using each of these machines. The side delivery rake when everything is working nicely, weather, men and tools; the wide two-horse



SIDE-DELIVERY RAKE (TOP) AND HAY TEDDER (BOTTOM).



TWO STYLES OF HAY LOADERS.

rake to hurry with when showers are coming and much hay needs to go at once into cock, or for gleaning the field after the hay has been taken off. The side delivery is not a good rake for gleaning.

The Hay Loader.—Concerning the usefulness of the hay loader in the alfalfa field there may easily be two or more opinions. It saves labor, sometimes. It may crumble and waste the leaves. It may cause the hay to be left in such shape that it is ready to take every drop of sudden springing showers. This is indeed the worst difficulty with the hay loader. It cannot take hay up unless left in the swath or windrow. It is not practicable to leave hay in the swath for it loses its leaves if exposed too long to the hot sun. Windrow loaders do not sacrifice so many leaves, but the hay is ready to be wet by every passing shower. On the other hand if one wishes to use ignorant and unskilled labor to put hay on wagons he may find the hay loaders an economical way to get it there.

There are various types of hay loaders. For alfalfa hay the best have endless aprons or strap carriers to take up the hay. The ones that push it up by aid of spiked wooden strips are not very efficient and knock off many leaves.

Sweep Rakes.—A better thing in nearly every way is the wide sweep rake for gathering the alfalfa together and conveying it for short distances to the barn or stack. These sweep rakes are operated each by one man. He goes afield, gathers his load

whether in swath, windrow or cock, brings it unaided to the mow or rick, leaves it there and without waiting for it to be unloaded goes afield for another load. Thus one man with a pair of horses will bring as much hay to the barn or rick if the haul is short as would four men and four horses with the hay loader. Furthermore these rakes gather the hay with the least possible loss of leaves since it is simply lifted up, pushed together and carried to the unloading place.

Hay Sleds.—The eastern farmer may not have use for either hay loader or sweep rake, because of the small size of his fields. He can use a simple hay sled to good advantage. These sleds are best made of boards ½″ thick of some hard wood if in the hard wood country, or they may be of ordinary ⅞″ stock boards. A size of 6′ wide and 12′ long is good. Make exactly as you would a barn door. Hitch a horse to the front end. It is well always to let these sleds rest when not in use with the front end supported on a stake about 24″ high. This makes it warp or curve a little and thus it draws easier.

On these simple and inexpensive sleds an active man will load an incredible amount of hay in a day, and a small horse can easily draw it to the stack or barn if the distance is not too great. There it is either unloaded by simply pushing it off, or the horse stops while the forks lift the hay.

Lifting to Stack or Mow.—Getting the hay from

the ground to the top of the stack or mow is ever an engineering problem that one must study. There are several ways of attacking it. One can arrange to take up very large bunches at a time and thus economize time. Under this system one must use two horses to elevate the hay, his ropes and lines wear out rapidly and the men on the stack are embarrassed by too much hay all at once. Or he may waste time by an inefficient fork and carrier that is forever getting out of repair and never takes up very much at a time. A happy medium between these is desired.

After some thirty years of haymaking I think that to lift drafts of about 500 lbs weight at a haul is about right, and I would rather go under that weight than over it. This gets the hay up rapidly enough and yet the men in the mow can handle it easily.

There are many forms of efficient derricks for lifting hay to the rick. We present illustrations of several types and there are others nearly or quite as efficient.

Grapple Forks.—How to lift the hay is one problem, how to get hold of it to lift it is another quite as important. I like the Jackson California fork for use in the field when stacking This will grasp an incredible weight of hay, as much as the men care to handle on the stack. It disturbs the hay very little and leaves it on the stack in good condition. Double harpoon forks do not work so well in the field as they do in the barn. There are effi-

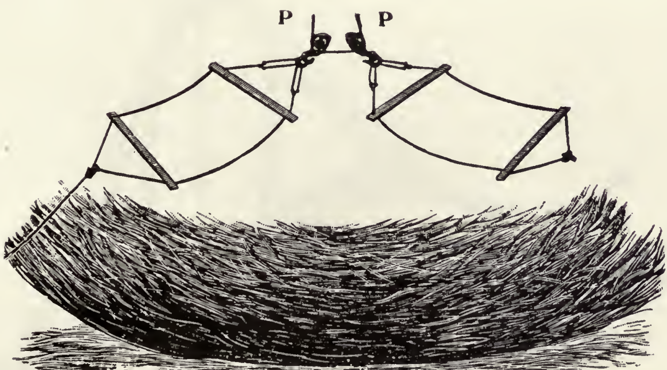
cient grapple forks made that will take loose hay and deposit it nicely on the stack.

Unloading Hay.—In unloading at the barn the problem is rather different, especially if the hay has been loaded onto wagons. It is then compacted so that forks have good opportunity to get hold of it. In barns, too, it is possible to arrange ideal tracks for unloading machinery. Good apparatus cost little more than poor. It is economy to put in the best.

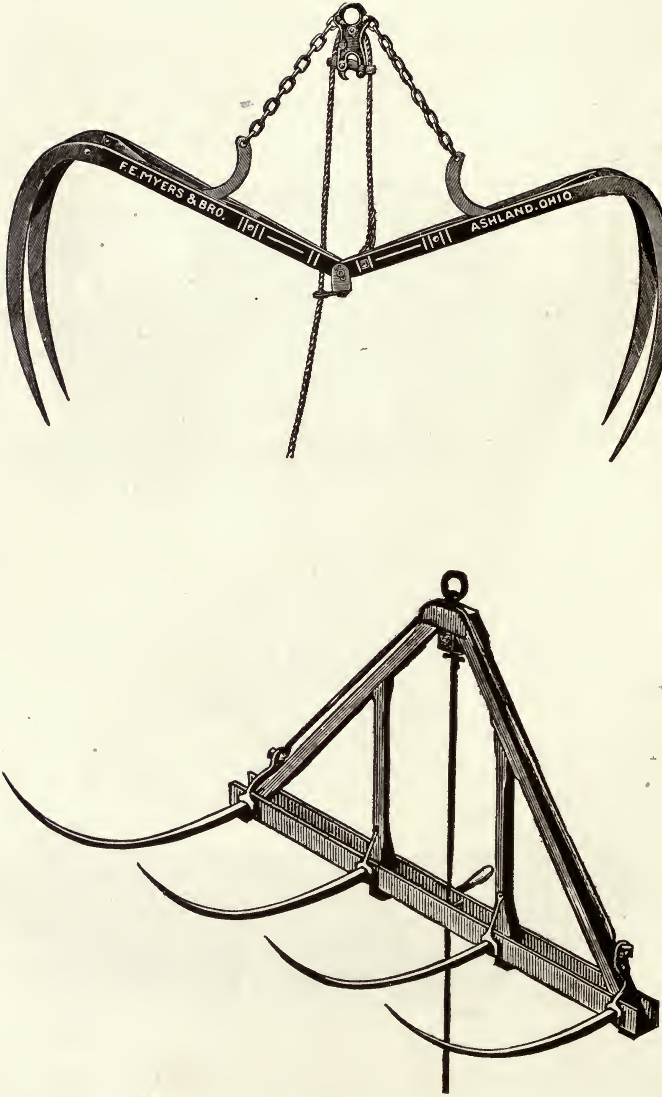
I would always build hay barns in such manner that there would be no cross-ties through the middle section, thus nothing to make it necessary to lift the hay to the peak in order to swing it in to the mow. There are carriers made that do not ever lift the load higher than will clear the level of the hay in the mow when it swings in. It swings in at any height desired, thus will put the hay clear into the peak, or will swing it in at the level of the mow floor. These carriers use either slings or forks.

Slings.—Slings are arrangements of ropes forming a sort of large net that is laid in the bottom of the load on the wagon rack. Pulley blocks with hooks in them are attached rapidly to each end of the sling and when it is lifted everything comes up clean from the rack. There is nothing swifter, cleaner or more efficient than the sling.

Curiously enough slings are not in common use. Perhaps the reason is that commonly men have sought to take off a whole load by putting in several



AN EFFICIENT HAY SLING.



TYPES OF HAY FORKS.

slings and lifting them in succession. This scheme ought to work well but troubles because men loading hay rapidly in the field forget to put their slings in at the right time, or else in unloading get hold of the wrong slings, getting one of the slings at the front end another sling at the rear. Thus each is drawn out and no hay lifted.

I avoid all this trouble by using only one sling, that placed in the bottom of the load. It would not do of course to attempt to lift a ton or a ton and a half of hay with one lift. Therefore the top of the load is lifted with forks. Two of these are used at the same time, one in each end of the load. As they raise they take off a layer of hay over the whole load just as a sling would do. A second layer is taken off by aid of the forks, and then the rest of the load is cleaned up by use of the sling.

By aid of these slings one can elevate alfalfa hay very rapidly. I have repeatedly taken off loads in five minutes, which would, if that rate be held, put in barn or stack 100 tons in a day. Of course men in the mow or on the stack could not care for hay at any such rate.

Care of Machinery.—A good deal of the success of any hay unloading machinery is dependent on the care of the apparatus. It pays to use large pulleys of the strongest make. It pays to buy the best rope. It pays to keep the carriers and pulleys well oiled. Nowhere else is intelligence and care better worth while than in the looking after hay un-

loading machinery. A hitch here and the whole work is delayed and often many men made idle.

The Open Center Hay Barn.—There are several advantages of building hay sheds and barns with open centers. There is time saved for one thing, since the hay is never lifted to the peak of the roof till the height of the mow makes it necessary. Then the hay never is dropped from a height, thus there is not such hard packing of the middles. This packing often results in a good deal of spoiled hay, especially if it is put away rather moist. It is easier on the men in the mow since they can push the hay one way or the other as it drops and thus do quite a little toward distributing it where needed.

HAY MAKING IN RAINY COUNTRIES.

Probably most of the readers of this book will dwell where showers come during hay harvest. I remember what terror filled the hearts of haymakers during my childhood, spent in Ohio. It was considered a calamity to have hay out when it rained and every energy was put forth to get the last forkful up before the storm came. Afterward when I began the growing of alfalfa it came over me with a feeling of dismay that with much alfalfa to harvest it would be impossible to avoid getting a lot of it wet. Later when my brothers and I had as much as 100 acres or more to harvest I learned that they would have alfalfa cut, in swath or in cock, during nearly every storm that fell in the entire summer. From observation and habit we at last learned the secret of making hay with no material damage in a land where rain often falls.

Not Hard to Cure.—Alfalfa is not a hard stuff to make into hay. It dries easier than red clover, for example. There is a principle to be observed in making alfalfa hay that applies to making hay from all clovers. If it can be so managed that the leaves are not at once burned and dried to powder the moisture from the stems is the more easily removed. Leaves are natural evaporators of sap; stems are not. Therefore, while the leaf has yet pliancy and

some semblance of its natural condition it is most efficiently carrying away the sap of the stem, but when it has dried up it no longer aids in drying the plant at all. Therefore, the best hay in all respects is made partly in the shade, in loosely turned windrows, in narrow cocks.

Raking the Hay.—This indicates the use of the side delivery rake. It is an admirable tool for helping cure hay. One can lay it up in loose windrows, hidden in part from the burning sun, yet penetrable by the air and do a good deal of curing there.

We do not make much use of the tedder. There are times when it should be used in very heavy hay, when very green and the earth wet underneath. The danger with the tedder is that one will use it too late and knock off showers of leaves. Careful use of the tedder is helpful; indiscriminate use of the tedder may do great injury.

The rake should always be started before the leaves are dry enough to crumble. Alfalfa leaves are worth about $25 per ton. They are worth as much, pound for pound, as wheat middlings. One must plan to save them.

There are occasions when unavoidably parts of the field will become too dry to rake without losing most of its leaves. Then let it alone till the sun has gone down. Almost instantly the leaves will regain their elasticity, and one can rake without losing them. The writer has done this several times and secured beautiful hay with nearly every leaf, giving

THE WORK OF A SIDE-DELIVERY RAKE IN ALFALFA.

the man who worked so late extra pay for his overtime. In raking such hay, which is of course very dry, it is best to make the windrows large.

Usually small windrows are best. We follow about this practice: The mowers are run when there is leisure to run them, paying little attention to time of day. Usually several of them are started at one time, when teams can be spared from other work. It is well if the dew is off the alfalfa before it is mown, but convenience sometimes makes us disregard this practice.

Cocking the Hay.—As soon as the hay is tough and the leaves as dry as it is safe to allow them, the rakes are started and small windrows made. At once men follow with forks and cock the hay up in the old fashioned way. Care is taken to make the cocks small in diameter, and as high as they can be safely piled. The workmen are shown how to take the hay in small forkfuls and lay it up, one forkful squarely above another, till the cock is made. This with a little practice is rapidly done. It seems a costly thing to one not accustomed to this sort of handling of hay, yet a skillful and energetic man will easily cock up ten tons or more in a working day. So the added labor cost is hardly more than 20 cents per ton from cocking up. And when the hay is later taken up it is handled so rapidly that some credit must be allowed for that.

Hay cocked thus green is tough so that the stems naturally droop from their own weight. The result

is that should rain come that night it would hardly penetrate the hay at all. And being yet somewhat green and hardly dead as yet rain would not do much injury if it did penetrate.

Loading on Low Wagons.—Towards evening it is probable that there will be found some hay dry enough to go to mow or stack, so a number of wagons will be loaded and run into sheds as the last ceremony of the day.

This last item is of more importance than one would at first think. In a showery country it is exceedingly useful to have facilities for rapidly assembling a lot of hay and putting it in shelter as night closes. The Woodland Farm hay wagons are assembled with low wheels and broad tires and have platforms tightly boarded over, each platform 7′ wide and 16′ long. At each end standards help the loaders. On such a low platform wagon it is not at all difficult to place two tons of hay, taken from the cock, or 3,000 pounds from the windrow. On the wagon platform is laid the one sling that goes underneath the load. If care is taken to have this right side up no other mistake can well be made with it. On Woodland Farm seven of these wagons are used. Some might suppose this a costly preparation, but really such a wagon with low broad iron wheels and simple running gears, with the platform built on it, costs only about $40 and may be had for less and be nearly as good. The advantage of them is that they enable a man to hurry in away

from approaching storm or nightfall a lot of hay, and this can be all unloaded at leisure next morning when dew is on the grass, or it may be showering.

Opening the Cocks.—The hay in the cock will be left unopened till the dew is well off and the outside of the cocks well dried, say till 9 or 10 o'clock. One can never lay down cast iron rules for hay making. The hay in the cock may not need opening at all, but the chances are that it will if it is to go in at once. Sometimes it can be left for a few days in hot, dry weather and it will perfectly cure in the cock. I do not often do this; it is taking too much chance. By 10 o'clock, if the day is fair, men are busily opening the cocks that were laid up the evening before. With timothy hay one tears it all apart and scatters it as much as possible when he opens it. With alfalfa, on the other hand, one lifts it tenderly and puts it out in three, four or more large flakes, just as the cock was laid up—this to avoid loss of leaves. These flakes lying under the midday sun soon dry. After dinner maybe they will need turning over once. This is very rapidly done. Then one man goes along and lays them in cock again, just as he would pile up buckwheat cakes. This is done very fast indeed, and the hay laid up again goes right on drying. Wagons follow and it is taken as fast as possible to the barn. Late in the day there may be more hay to rake and cock.

This is the system followed on Woodland Farm, and almost no hay is lost no matter how it rains.

Keep Hay from the Air.—As soon as alfalfa is half dry it ought to be kept from the air except in dry weather. That is, if it should happen to rain and the hay is lying in the swath it will be much injured; if it is in windrow it is less hurt, and if in cock it will probably be hurt none at all. So keep it away from the air as soon as it is getting dry and dews or rains are coming. This lesson can not be too well learned. Alfalfa once thoroughly dry, then wetted, is much more injured than if it is only half dry when rain falls. While I am always rejoiced at dry weather during alfalfa harvest yet I expect to see hay in the field during almost every rainstorm of the summer.

Degree of Dryness.—Our rule is to dry hay as dry as we can. How dry is that? Seldom as dry as we would like, certainly. Our test is to take a wisp of hay, choosing some of the moister part, and twist it hard to see if we can wring any moisture from the stems. If we can not we put it in the mow or stack as fast as we can get it there. One can put in hay with some moisture in the stems but moisture of rain or dew is sure to spoil the hay. We learn that the larger a body of hay is put in in one place the moister it may be and not spoil; that when only one or two tons are put in a small mow together the hay can hardly be too well cured when it is put in, but that mows with 50 or more tons together will keep well even if the hay is pretty tough when put in. The heat generated by the hay in curing dries

ALFALFA HAYING ON AN OHIO FARM.

out the large mass and no doubt destroys the germs of mold as well.

Brown Hay.—This heating in the mow destroys the green color of alfalfa and makes it brown or yellow. It does not therefore appear so attractive yet most animals eat it all the more greedily for this heating that it has undergone. It has not really been injured except that it has lost a little in weight. Storer very nicely says of this brown hay:

Besides the plan of having hay undergo in the making some slight fermentation, in connection with the true sweating, there is another much more emphatic conception put in practice in the process of making brown hay, so called. This is a process which is dependent upon decompositions that are a good deal more incipient; but which has nevertheless found favor in many districts, especially in countries where the weather can never be depended upon for making hay by the usual process.

In making brown hay, most of the water of the grass is driven off by the heat of fermentation, only about a third of the original moisture being dried off by sun and air in the first place. Far from seeking to bring the hay into contact with the air, the chief care in this process is to exclude air from the hay. For making brown hay, grass that has been wilted to such an extent that the leaves have shriveled, although the stalks are still plump, is heaped up either in rather large masses or in smaller heaps that have been trodden in such wise that the air shall be well-nigh or altogether excluded from the interior of the heap. Under these conditions, fermentation soon sets in and proceeds with a good degree of regularity. In the course of it the heap becomes very hot, often as hot as the temperature of boiling water, the hay takes on a deep brown color, and gives off an odor of caramel or burnt sugar.

In point of fact, some of the constituents of the hay undergo the well-known fermentation which chemists distinguish as the alcoholic, the lactic and the butyric; in other words, a considerable part of the carbohydrates in the hay, notably the sugar and the dextrin, are changed to alcohol, carbonic acid and lactic and butyric acids. Of course, a considerable proportion of the carbohydrates are destroyed by these changes. The large amount of heat that is developed comes from the destruction of these

things. Some persons have thought that enough heat is developed to kill the germs of hurtful fungi which may have existed upon the grass, and that the hay is thus protected from moldiness and from putrefaction. More probably it is the copious evolution of carbonic acid during the fermentation and the lactic acid formed which hinder the development of the microdemes that cause putrefaction.

Brown hay that has been properly prepared is greedily eaten by cattle, and readily digested and utilized by them. Since the fermentation destroys a larger proportion of the carbohydrates of the grass than of the albuminoids, it follows that brown hay must be a somewhat more highly nitrogenized food than ordinary green hay.

There is a certain analogy between brown hay and black tea. Black tea is made from the same kind of leaves as green tea, and the leaves are plucked at the same stage of their growth. But for making black tea the leaves are fermented in heaps before drying them, while for green tea the leaves are dried directly.

The real justification for making brown hay is that the farmer becomes independent of climate, and that even very weedy grass may be saved in this way in the worst of seasons. Much labor is required, of course, in raking up and carrying the heavy green grass. The loss of dry organic matter in making brown hay is large. Probably it is never less than 14% or 15% of that originally contained in the grass, and the proportion is frequently much larger than this.

Management in the Mow.—The hay mow is a hard place, especially when one is rolling in tough alfalfa at the rate of a ton every ten minutes. Therefore it needs good men and plenty of them. In order to have the hay cure nicely in the mow it ought all to be moved, or nearly all. The practice of letting the hay pile up in the middle as it falls from the carrier, rolling to each side, is a pernicious one. It makes the hay very hard to get out of the mow and there will be more mold and damage in the middle than there would if the hay was kept level in the

ALFALFA GOING INTO THE HAY MOW.

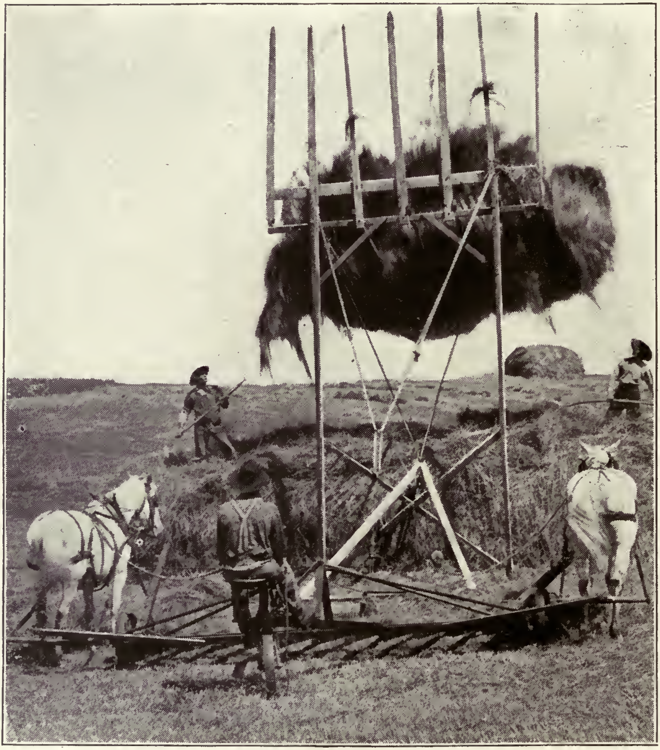
mow, or a little higher on each side than the center.

There ought to be no beams or ties or anything in the mow for hay to rest upon. Where it is held up by cross beams some of it may damage.

Curing Green Alfalfa.—In a small way hay can be made by mixing quite moist half-cured hay with bright dry straw or last year's hay. I have often done this, laying down first a layer of straw, then a layer of alfalfa, another layer of straw and thus on till the mow is full or the supply of dry material is exhausted. Shredded corn fodder is a good material to use in this way and it is notable that when the mixed foliage is fed out the animals will eat both the alfalfa and the other material mixed with it. Perhaps some of the flavor of the alfalfa is imparted to the other material.

Stacking Out of Doors.—In the West little care is taken in building alfalfa ricks. They are often as wide as 25′ and the tops very flat and poorly adapted to shedding off rain. In the East this will not do; the whole stack would become rotten. Alfalfa keeps all right in stack or long rick, but there are certain things to bear in mind. Good foundations should be built high enough off the ground so that air circulates under them freely. They ought to be no more than about 16′ wide at the base, with a good bulge higher up, and built as high as practicable. We build them on Woodland Farm 25′ high. They should not be too hastily finished, as they will settle unevenly and it is better to put the top on the

second day after building. The tops must be of wild hay, timothy or some such material that will shed water. Alfalfa alone will not shed water at all well.



MODERN METHOD OF STACKING HAY.

There are covers made of wide boards that serve well. These boards are held in place by use of specially constructed chains in which the boards are slipped. The boards ought to have two good coats

of paint before being used; a light colored paint is best. Canvas stack covers are of use. They decay rapidly when left on the stacks for a long time. Steam arises from the stacks and condensing on the canvas covers keeps them constantly moist and warm, favoring decay.

Use of Hay Caps.—Hay caps of stout cotton cloth or light canvas are very useful. They may be about 48″ square and should have weights at each corner. A convenient way to make these weights is to make them of balls of moist cement. By putting a hole as large as a cent piece in the corner of the square and squeezing the ball of cement so that it will surround the corner of the fabric and pass through the hole it will become very firmly attached. If the cement is as large as an orange it will do no harm and hold on the covers all the more securely if the wind blows, which it usually does before rain. These weights are far better than cords and pegs which get inextricably tangled in handling covers.

The objection to the covers is the trouble of using them, gathering them up again and taking care of them. However, where hay is as valuable as it is in the Atlantic states I advise their use by all means. There is one danger; it may lull the user into a feeling of security that will prevent him hastening as he ought. Thus the new growth may spring up and be turned white beneath the cocks. Hay caps or no hay caps, make it a rule to make hay while the sun shines.

Salting Hay.—An old practice is that of adding salt to hay as it goes in the mow with the idea of better preserving it and also making it more palatable to the animals. There is something in each belief. It is not true that enough salt may safely be added to keep very wet hay. I have tried this during wet seasons and am now satisfied that if salt enough is added to make hay keep, it will not be safe hay to feed to animals after it has kept. However, when hay is only a little moist there is no doubt that adding a portion of salt abstracts some moisture and helps its preserving qualities. Animals too relish hay better if it is slightly salted, and no doubt they thrive better to have their salt mixed with their food. As to the amount of salt that should be put on the hay, I would not advise more than 10 or 12 lbs. to a ton of hay. Hay that has been slightly salted is tougher when taken from the mow and loses its leaves less and is therefore better to handle and better to bale.

Do Not Dry Hay Too Much.—Alfalfa hay may be dried too much in the field. If this is done it will not handle well nor will it pack well in the mow. Thus one will not get nearly as much hay into his mow as it ought to hold. Perhaps no one can describe to another how dry hay ought to be. It takes experience to teach this, and one must learn to know the feel of it. If the hay is harsh and brittle it is too dry. If it is damp and limp it is too moist. If any moisture from rain or dew is on it it will spoil.

Internal moisture from the stems and leaves will not do half the harm that dampness of rain or dew will.

The Sweating of Hay Mows.—When one puts in a mass of alfalfa hay in the right condition it is sure to become hot and this heat makes vapor, almost steam. This rises and condenses on the top layer of hay, making it moist. Thus there may be a little moldy hay on the very top of the mow. It is well to put on a layer of very dry hay at the last, if this is convenient. One need not feel troubled or anxious about his hay merely because he finds it sweating and some condensed steam on the top layer.

Spontaneous Combustion in Hay.—Alfalfa hay put in with considerable moisture in the stems becomes intensely hot in the mow. It may be only hot enough to cure nicely or it may, if put in too green, become hot enough to ignite. I once stacked hay in October when because of humid weather I could not get the hay dry. At length in despair it was put in the stack in a very moist condition. A large rick was built of it, only half cured. This rick heated to such an extent that part of it was charred, some was made into excellent silage and, with the exception of a very little mold, the rest was excellent brown hay. It is notable that stock like better this brown hay than hay that is dried so that it cures with the green color. The fact is the great heat developed in curing under-dried hay partly cooks it; there is a loss in carbohydrates, but the hay is richer than ever in protein and no doubt more digestible.

This rick of silage and charred hay would have burned had we helped it by opening it and admitting air at the right time. By leaving it alone it died from smothering; there was not oxygen enough in the mass to make it burn. There are, however, a good many instances of spontaneous combustion occurring in alfalfa ricks and mows in Kansas where the very rank growths are often put up without sufficient drying. It is notable that in many instances recorded the fire breaks out after the farmer becomes alarmed at the hotness of his mow or stack and goes to open it out, when it gets air, takes fire and burns. It is doubtful if there would often occur a case of spontaneous combustion if the barn was fairly tight and no air was let in by braces or beams running into the mow. The best thing usually when one fears spontaneous combustion in mow or stack is to watch it and carefully avoid opening it or doing anything to let the air into the mass.

I once put green oat hay into the mow, a great many tons of it, and spontaneous combustion set in in this mow, and steam filled the lower story for days. We kept adding hay above and thought little of it. The mass cooled down, but when the hay was taken out there were tons of charred hay that could not be handled with the fork. It seems that had we dug into the mass we would have lost the barn.

There is practically no danger of spontaneous combustion unless the hay is put in much too green and moist.

SOILING AND PASTURE.

There is great advantage in soiling cattle rather than letting them run on the land and eat at will. An acre of land will carry three times as much stock if the crop is cut and taken to the animals as it will carry if they are allowed to run upon it. When alfalfa is the soiling crop an acre will carry about the same number of animals that five acres will pasture.

There are good reasons for this. Animals grazing tread down and injure both the soil and the plants. Alfalfa is not perfectly adapted to being depastured. Grasses are natural pasture plants. They make growth from the lower end of the blades. Thus when the upper ends are eaten off the new growth pushes them on up again. However, even grasses are weakened by being eaten too close. Alfalfa grows from buds and if these buds are eaten off then no growth can take place till new buds have started again. Thus it is clearly much more advantageous to let the alfalfa mature and cut and carry the forage to the animals than to feed it off by depasturing.

Advantages of Soiling.—There are other advantages in this manner of feeding alfalfa. It seldom or never bloats animals when it is cut and taken to them, even if fed very green or with the dew on it. For some reason, perhaps because when eating

cut alfalfa they eat the stems as well as the leaves, animals rarely bloat on cut alfalfa. I have practiced feeding it to steers and ewes and have never seen a case where it gave trouble. Certainly no animal eating alfalfa either green or dry should ever be allowed to get very hungry before getting its feed.

Further, alfalfa is so rich a feed that no other soiling crop that can be mentioned is as good, and it is so very easily grown. One can grow as much as 25 tons per acre of green alfalfa on any good, deep soil, and this forage is richer in elements going to make growth and muscle and milk than almost any that may be named.

Tests of Soiling.—The Nebraska Station reports that in an experiment conducted there it required .71 of an acre to keep a cow for a given time by soiling, while by pasturing it required 3.63 acres.

In New Jersey Prof. Voorhees said that the first cutting of alfalfa yielded nine tons per acre, the second 7.73 tons, the third 4.89, fourth 2.75 and fifth 2.23, or a total yield of 26.60 tons of green forage. About 30 to 50 lbs. per day of this green forage will be consumed by a cow. At the maximum rate an acre of alfalfa would feed 36 cows one day, first cutting, and to feed that number of cows safely through the season from the middle of May until late October would take about 40 acres only of alfalfa. Allowing something to give good margin, one can feed splendidly 36 cows on 50 acres of alfalfa and have chance to make quite a little hay as well from the field.

Double System Best.—But this would hardly be the most profitable way to use either the cow or the alfalfa. A partial system of soiling in connection with a good pasture is the better way. Thus if the cows were put daily in the stable, or fed in racks, with 20 to 25 lbs. of green alfalfa and then given access to a good pasture of almost any sort of nutritious grass the results would be much better. For making beef I found that when racks are placed in the bluegrass pasture and are filled daily or once in two or three days with green alfalfa, the cattle made splendid growth. When in addition a small amount of corn was fed them they made probably the most rapid and cheapest gains possible.

Early Cutting Hurtful.—Alfalfa makes early growth for soiling, but it is bad for the plants to be mown off too early. In England where alfalfa is chiefly used as a soiling crop for horses the alfalfa is much weakened where it is cut too early, along the top of the field where cutting begins. On Woodland Farm, where alfalfa has often been cut for soiling sheep, it has been observed that where the cutting was premature the alfalfa soon became unproductive and weeds and grasses came in.

If therefore it is desired that the field endure for a number of years it is well to wait till near the time of bloom before beginning to cut, even for soiling. Or it may be felt to be cheaper to sacrifice a little of the field in order to take advantage of the first available growth. In this case the strip mown

too early may be plowed and resown in late July after being cut two or three times.

Repeating the Mowing.—Once one gets started over the field cutting for soiling he ought to manage to come around with his second cutting in about 35 days. This is not very difficult to manage. Supposing the normal time for alfalfa harvest to be June 1, if he begins cutting for soiling on May 15, which he very easily can do, and cuts a strip each day till June 20, he will not find the crop very woody, and by that time his first cutting will be ready to go over again and so on in rotation all summer long.

Soiling for Dairy Cows.—Doubtless the dairy cow relishes green food most of any farm animals, and needs it most. There is something about green sap that makes milk. Dry that sap and it never is so good again. Then dairies are often situated in regions where feeds are dear. A man keeping cows near any of our eastern cities can find immense profit in growing alfalfa for feeding green as well as dry. There is not a dairyman with a little farm land who can not grow alfalfa with splendid profit. He has the manure for starting it, he has the market in his own animals for the forage. If he can make a living at all in the dairy business he can make money, and plenty of it, with the aid of alfalfa and soiling.

Soiling on Pasture.—I have already mentioned a system of feeding that combines practicability with economy and gives good results, that is the feeding of green alfalfa in racks on pasture. These racks

should be large, so that they will hold at least a day's supply of forage, and they may just as well hold enough for two or more days. They ought to be on runners so that they can be readily moved by attaching a team of horses. Thus the racks need not stand in any one spot long enough to kill the grass there. And wherever they stand the grass will be wonderfully thickened and improved.

Cows will give more milk and make it cheaper to have the run of a grass field in connection with alfalfa soiling than when they are soiled on alfalfa in the stable. There is also a great economy of labor in this practice since there is no manure to handle, and if the racks are moved often the spread of fertility over the grass field will wonderfully improve the pasturage.

In cutting alfalfa for soiling one ought always after the first cutting to be governed by the growth of the buds or shoots at the base of the stems as already directed. Thus the vigor of the plants will not be disturbed and the yield will continue undiminished for several years.

In the San Joaquin Valley, of California, are many very great alfalfa ranches and farms. I have seen there large dairies fed on green alfalfa and on alfalfa silage, it being found better to ensilo the alfalfa in order to soften the prickly beards of the wild grasses infesting the fields. The more common practice throughout the San Joaquin Valley, however, is to pasture the alfalfa in summer and feed

in winter cut alfalfa that has been moistened and sprinkled with barley meal, about four pounds of the meal to thirty pounds of alfalfa, or even a less amount is often used and fed to steers, dairy cattle, and in fact to all sorts of live stock.

Green Alfalfa in Dairy Rations.—New York has made valuable experiments to determine the cost of milk from alfalfa and from other sources of succulent forage. Concerning alfalfa on the Geneva station farm, Bulletin (No. 80), says:

Alfalfa has grown well on the station farm, although the soil is a rather heavy clay. A field of alfalfa of 2.28 acres, sown in 1890, yielded this season (1894) for the first two cuttings—the first during June and the second about August 1—at the rate of 24,500 pounds of green forage per acre. On account of very severe drought the third cutting was very light and only part of the field was cut for the fourth time. Another field of alfalfa of 1.3 acres, sown in 1893, yielded at the rate of 33,800 pounds of green forage per acre, as the total for four cuttings. The last two cuttings were very light on account of severe drought. The first two cuttings, from May 11 to 31, and from July 9 to 28, yielded at the rate of a little over 12 tons of green forage per acre. These fields had been steadily cropped and not well manured for some years before sowing to alfalfa, and were not in condition to produce heavy crops.

The importance of feeding leguminous crops has led to many inquiries concerning the value of alfalfa as forage for milch cows, for the alfalfa is much liked by cattle and other animals and contains an unusually large proportion of nitrogenous constituents. The rapid growth of the plant, which can be cut three times during the season, and often four times, makes it especially worthy of consideration where soiling methods are practiced.

Then follows an account of very careful and accurate experiments with cows, feeding various grain and hay rations, with green peas and oats, clover, corn silage and sugar beets. In every instance the

comparison was in favor of the alfalfa, taking into account the ease with which it was grown and harvested and the improvement to the soil that follows its use.

The whole bulletin is well worth study, but I reproduce only the general observations:

These feeding trials here reported, though many of them for periods necessarily rather short, were repeated for several seasons and are the average results from a number of different cows, so that the indications which they all give of the value of alfalfa can hardly be considered accidental.

The average of all the analyses made of the fourteen lots of alfalfa used in these feeding trials will give an idea of the general composition of alfalfa forage. The average composition of three lots of mature corn forage might be considered beside that of the alfalfa for comparison as follows:

	Alfalfa forage.	Corn forage.
Per cent of moisture	75.10	71.80
Per cent of ash	2.28	1.20
Per cent of protein	4.48	2.27
Per cent of true albuminoids	3.53	1.97
Per cent of crude fiber	6.59	5.17
Per cent of nitrogen-free extract	10.26	18.46
Per cent of fats	1.29	1.10

In determining the cost of milk, for purpose of comparison, for each period reported in the preceding tables, the cost of the food only was considered. The manurial values of the foods were not taken into account, although under favorable conditions the net cost to the farm of milk would be much influenced by the fertilizing values of the foods. The manurial values of rations containing alfalfa and of those containing highly nitrogenous grain foods would be much greater than of most rations, but except where especial attention is given to careful handling of manure, only a small proportion of the possible amount would be recovered.

When alfalfa forage was substituted for some other food or the amount of alfalfa in the ration increased, there followed, in ten instances a decrease in the cost of the milk, in two instances a very slight increase in cost, and in two instances the cost of milk was practically the same. There was an increase

in the yield of milk in seven instances, a decrease in four instances of about what might normally be expected to occur without change of food, and little change in yield in three instances.

When the change was from a ration containing alfalfa to one containing less or no alfalfa, there followed an increase in the cost of milk in ten instances and there was about the same cost once. There was a decrease of the milk yield in nine instances, and an increase of the milk yield in two.

When alfalfa was substituted for other foods in the ration or the amount of alfalfa increased there followed a decrease in the cost of fat in seven instances and an increase of the cost in six instances. There was an increase of the amount of fat in six instances, a decrease in five instances, and little change in amount twice.

When the change was from a ration containing alfalfa to one containing less or none, there followed an increase in the cost of fat in nine instances, a decrease in cost once, and there was about the same cost twice. There was an increase of the amount of fat in three instances, a decrease in three, and about the same amount of fat in five.

When the change in the ration was to more alfalfa, or to alfalfa in place of some other food, there followed a decrease in per cent. of fat in milk in six instances, an increase in three, and little change in per cent. in four instances. When changed from a ration containing alfalfa to one containing less or none, there followed an increase in per cent. of fat in six instances and a decrease of per cent. in five.

There has been usually an increase in milk yield accompanying the use of alfalfa, although there was often at the same time a decrease in the per cent of fat. With alfalfa forage, rated at the same cost as other forage, there was generally a decrease in the cost of milk when the alfalfa was fed, and not much change in the cost of the fat produced.

Corn forage (fully matured), in the results accompanying its use, has compared most favorably with alfalfa; but except in the form of silage it is only available for a short time in the fall before frost. Alfalfa is ready for the first cutting about the time of planting corn, and about as early as rye forage can be cut. The proportion of constituents also differs so widely between alfalfa and corn forage that these plants can not well be considered as substitutes for each other, but as supplementary. For making rations like those usually fed, coarse fodder and grain foods, in general cheaper than those used with corn forage,

can be used with alfalfa. The more highly nitrogenous grains and hays fed with corn silage or forage, however, have a much higher manurial value, which is often of wide importance.

The palatability of alfalfa or of corn (maize) is greater than of most other forage plants of rapid growth that will yield heavy crops. This is a matter of the greatest importance.

From my own experience I believe that there is hardly anywhere a farmer who could not use a small field of alfalfa profitably in summer as a soiling crop. There are always dry times when grasses fail and cows shrink in milk; there are pigs and lambs and horses, all of which relish green feed and particularly if it is the delicious alfalfa forage. It is an insurance against drought and an acre of good alfalfa cut and fed green to stock will give as much as ten or more of average pasture grasses.

Alfalfa for Soiling Horses.—In all Europe much reliance is placed on fresh-cut green feed for horses in summer time. Sometimes it is vetches and rye, sometimes grass, sometimes alfalfa. And alfalfa or lucerne is the most prized and best relished of all the forage plants cultivated over there for feeding green to horses. Horses fed a daily ration of green stuff keep in far healthier condition than when fed on dry hay throughout the summer. With green alfalfa available the grain ration may be considerably lessened. The alfalfa should not, however, be cut for horses till somewhat mature, at least at the stage when it would be cut for hay. Working horses may go to pasture at night in which case soiling is not so necessary. They may have the run of an alfalfa

pasture and will do well on it. However, the same truth applies to pasturing horses on alfalfa as applied to other animals—an acre cut and fed to them will go as far as three or more acres pastured.

When there are mares, foals and idle horses on pasture it is an excellent plan to give them a daily ration of green alfalfa as has been suggested for the cows.

Alfalfa for Soiling Sheep.—I was struck by the great use made of soiling crops in France. There one would sometimes see a large flock, consisting may be of 2,000 head, all kept during great part of the day in some fine old stone stable or shed, there eating green clovers with the bloom on. And a great part of these clovers would be alfalfa, mixed no doubt somewhat with sainfoin or red clovers. What fine, healthy flocks they were! How free from all traces of stomach worms! It made me feel that we in America know very little yet about keeping sheep.

The ruin of American flocks usually is the hateful parasite. It gets in its work when sheep are pastured for successive years on our old bluegrass pastures. When sheep are soiled on alfalfa, or on almost any cultivated crop for that matter, the parasite can not gain entrance and the animal remains in health. A healthy sheep is pretty sure to be a fat, contented and profitable sheep. The labor of soiling sheep is the one objection to the practice. It is well repaid, however, in most instances, since the results are so very good.

Method of Soiling.—One ought to have barns or sheds well adapted to the practice and more or less dry straw is needed. If he has airy sheds that he can drive through with wagon or cart, arranged with racks on either side in which he will place his green alfalfa or other forage, a flock can be fed in very few minutes. A man with mower, rake and team would easily feed and care for 1,000 sheep. A lesser number would be a little more costly to feed, certainly. When one has a flock of pure-bred ewes and wishes to grow the best of lambs he had better try this soiling system, with a little dry hay and grain in addition to what alfalfa they wish. It is a joy to see such lambs as will grow up under such a system. It has been often tried on Woodland Farm.

Keep Sheep from Small Pastures.—It must be borne in mind when soiling sheep for prevention of parasites that they ought to have no run to grass. There should be an absolutely clean lot, with no weeds, no grass; then the airy, cool shed, the feed racks, the water and salt. If there is a small grass lot on which they also run it is certain that they will pick up myriads of parasites there and then the owner will say in disgust, "Soiling sheep will not keep them healthy." It will keep them in health, if they cannot get the parasites from the vegetation springing up from where their droppings have been deposited at some former time. Lambs kept in yards absolutely clean, fed on soiling crops, grain and hay, will be as big at six months old as they

would at a year given the run of pasture infected more or less with stomach worms.

Sheep Husbandry in the Cornbelt.—How can we have a great and successful sheep husbandry in the cornbelt? By first building wide sheds, with room to drive through easily, and hay storage above. Feed the sheep in these sheds during the winter and give the run of pastures. There is no danger then, with chance to glean corn stalks or what not. In April confine ewes and lambs to the sheds, feed them green alfalfa and other green crops, with a little dry hay. Do this and failure is nearly impossible. Do it in a large enough way, with 500 ewes in charge of a good man and it will pay well. If you have had stomach worms among your sheep and lambs, try for one year keeping them in a cool, airy barn basement, with no grass whatever, nor weeds, in their small yard (they need no yard at all for that matter) and see what splendid lambs you will get. Of course there is the fear that the ewes may get too fat to breed so treated. This may be overcome by taking the ewes from the lambs when the latter are weaned and putting them out on rather poor pasture for a time, or in some way naturally reducing their flesh if they are inclined to be heavy and lifeless. Lambs never get too big or fat; growth takes care of that.

Alfalfa for Soiling Swine.—When a rancher I had my first experience with soiling swine. I kept a few old sows in a log pen and each day cut a few swaths

of green alfalfa and threw over to them. With no other food during summer the sows and pigs thrived quite well. They did not fatten at all, but the sows gave milk and the pigs grew. Later in the season when corn ripened they were given corn or squashes in addition to their alfalfa and then they fattened off readily.

When hogs must be kept in pens they should have green stuff abundantly supplied. There is probably nothing else so good for them as green alfalfa. It should not be allowed to get woody. It is probable that it is more profitable to cut the alfalfa green and feed to the hogs than it is to let them run on it when land is worth $100 per acre and alfalfa hay commands $10 per ton. Where land is cheap and hay is cheap and alfalfa is a plant easily established it is no doubt better to pasture than to soil.

Alfalfa for Poultry.—When fowls are confined to yards they thrive much better when fed green stuff and there is nothing they relish more than green alfalfa. It is, moreover, an exceedingly rich and well chosen food for them, especially for laying hens and growing chicks. It may be fed to them whole or cut into very fine bits, when they will consume nearly all of it.

AS A PASTURE PLANT.

It may almost be said that alfalfa is unfitted for pasturing. Grasses grow by the increase of the lower parts of their stems and blades. They therefore do not suffer from being nipped off, as they can yet push up from below. Alfalfa, on the other hand, grows from terminal and lateral buds. If these are bitten off, growth must cease until new buds can form and growth starts anew. Again, grasses are safe pasturage and alfalfa a risky one, because of the danger of animals, in their greed, so gorging themselves that they suffer from indigestion and consequent bloat.

Notwithstanding these facts very many farmers pasture alfalfa with great profit and almost every man growing it will desire to pasture it more or less. The brief study of the conditions under which it may be most safely pastured will be profitable.

Care in Pasturing.—For the good of the alfalfa, animals must never run on the field when it is frozen nor when it is soft and muddy. To tread on frozen alfalfa crowns is to destroy them in most instances. Therefore, as soon as a hard freeze comes all stock should be taken away from the alfalfa field, and the gates locked.

Animals must not be permitted to gnaw it too close. A small field of alfalfa thrown into a large

grass pasture will soon be destroyed, without affording a great amount of feed, because stock will hardly eat any other thing while they can get the alfalfa, and it will have no chance to grow at all. It is hardly safe for a man to attempt to pasture his alfalfa while it is in the experimental stage. He should wait until he has established fairly wide breadths of it; then he can set aside portions of it for that purpose.

Pasturing and Mowing.—A combination of pasturing and mowing off is most economical and satisfactory. Divide the area to be pastured into three lots. Turn out stock on one, and when they have eaten a part of it, turn them to the second enclosure and mow off the first, taking away what they have left. There are always parts of the pasture more palatable than other parts; animals thus graze unevenly; the mower evens it up, and what was discarded in summer proves to be acceptable in winter. After grazing down the second enclosure sufficiently, the animals will be turned to the third part, while the mower will finish cutting the second lot. Then after a time they will come back to the first enclosure, which will be all evenly grown up and about at the blooming stage. Managed in this way, alfalfa will endure grazing for many years without injury, while if allowed to be eaten close in spots and not eaten at all in other spots, it soon becomes weakened and grass invades it and the good stand is lost.

Danger from Bloat.—There are stages in the growth of alfalfa when it is much more apt to bloat stock than at other times. When the soil is moist and the weather warm and growth rapid, when the soil is very rich also, there is induced a very rank growth that is quite apt to cause trouble. This danger is worst when the alfalfa is young and tender; increasing safety comes with advancing maturity until, when it is thoroughly in bloom, there seems little danger to animals accustomed to its use.

Perhaps there is never absolute safety in pasturing sheep and cows on alfalfa, yet the writer has for many years pastured valuable sheep all summer on alfalfa, with a run on grass when they wished; and in some years his loss has been so trifling as to be not worth considering, while occasionally it has been necessary to take the sheep off for a time to allow the alfalfa to harden up. In several years' experience with cattle he has lost but one, and that one from permitting it to graze very immature alfalfa that had been mown about two weeks and that, owing to the nature of the soil, was making a very rank growth. There is never danger with pigs so that they are not too hungry when first turned on the alfalfa, nor with horses if it is not too watery and immature.

It is, however, an art to accustom animals to eating alfalfa in pasture. The plants should have made a considerable growth, almost having reached the blooming stage, before being turned on.

Turn on Full.—The animals, whether sheep, cattle or swine, should not be hungry when turned on. They should be allowed to fill themselves completely with bluegrass, should have a ration of their usual grain, if they are eating grain; then at about ten o'clock, when they do not care to graze longer, they should be introduced to the alfalfa pasture. It is well to stay with them until they have eaten what they will of the new forage and laid down to digest it; there will not be much tendency to bloat, but should there be it is well to be on hand. Being turned on at this time of day and stage of repletion, they will not consume very much alfalfa at first, and this is what you desire. Once filled up, the subsequent treatment is charmingly simple: they must never again be taken away from the alfalfa, night or day, rain or shine! The philosophy is that treated thus they never become hungry and thus take in but a little alfalfa forage at a time.

The usual practice of turning in for fifteen minutes the first day, half an hour the second day, an hour the third day and so on, is the worst possible to conceive, as it brings the cattle every time hungry to the field, and in fifteen minutes they can pack an immense amount of alfalfa into their stomachs. We have permitted sheep to leave the alfalfa fields during the heat of the day and come to the barn for shade and water. About ten in the morning, earlier during very hot weather, they would do this, and then at three or four in the afternoon they would

be driven back to the field. Thus they were on alfalfa all night and most of the day, and often with alfalfa hay in the barn to eat dry while sheltering from the sun.

Advantages of Grazing Alfalfa.—The advantages of alfalfa grazing for sheep are great. Grazing high they escape all sorts of intestinal parasites that so afflict sheep in America. The deadly stomach worm, once a scourge on Woodland Farm, has almost completely disappeared since alfalfa pasture has become our reliance. These parasites find their way to the ground from the droppings of the ewes; the germs develop there somewhat and perhaps by entwining about the moist grass are again taken into the stomachs of the flock, this time to distress the lambs. Intestinal parasites have very nearly ruined the sheep industry of the east. The old pastures become deadly. Alfalfa pasture has certainly been proved to be a remedy.

In a flock of a hundred ewes with their lambs, it has been usual to lose, presumably from alfalfa bloat, from one to half a dozen sheep and lambs during the summer. From stomach worms it was once my experience to lose twenty, and half the others to be seriously injured by the presence of the insidious scourge. The nodular disease also seems held in check by alfalfa pasture, and tape worm is unknown in our flock, for no other reason that I can see than that of the grazing of alfalfa. Of course, when grazing alfalfa one should be careful that the

sheep do not infect themselves in other small grassy lots where the short, sweet, rich grass may tempt them to bite close, for in these places infection lodges.

Curing Alfalfa Bloat.—Very often animals slightly bloated recover unaided. If, however, there is considerable distress the attendant should go at once to their aid. With sheep, take a stick about two inches in diameter, or a large cob, insert it between the jaws, thus keeping the mouth open, raise the head and gently press the sides between the knees. This will usually result in causing the gas to be belched off. A half pint of raw linseed oil, with a teaspoonful of turpentine added, is a relief, and the same mixture in larger doses relieves cattle. Sweet milk is said to relieve bloat in sheep.

Tapping With Trocar.—When it is evident, from the extreme tension of the paunch, that this will not be enough to save the animal, recourse must be had to the trochar. At a point on the left side the walls of the paunch and the skin unite in the cow and are close to each other in the sheep. Here an insertion may be made without causing the animal much pain, and a tube put in to allow the gas to escape. When pasturing either alfalfa or red clover, a trocar should always be at hand, for there is no telling when it may be needed. The trocar is better than the knife, as it opens a small hole and there is no danger of opening one too large; then, when the point is withdrawn the tube remains in the open-

ing, through which the gas escapes. In using any improvised tube one must hold to it or it may slip completely within the paunch and be lost, perhaps to the serious injury of the animal, though the writer once lost a piece of cane reed six inches long in the paunch of a sheep with no ill effect that he could ever discover, but what became of it has been always a mystery to him. After using the trochar, one should liberally disinfect the wound with turpentine or some carbolic disinfectant.

Cold Water or Ice.—In cases of bloat there is always considerable heat about the paunch, and indeed the rapid fermentation must produce an entirely unnatural heat which if it can be reduced may of itself cure the complaint. I learned from a Mormon ranch woman many years ago that ice heaped on the distended back of a bloated cow, with some kneading and keeping the head up hill, was a ready relief. This occurred when the ranch cows used to graze on frosted alfalfa in the fall and ice was at hand in the irrigating ditches. I have cured bloated ewes by pouring cold water on the region of the paunch.

This much space has been given the subject of bloat, not because it is so very dangerous, but because when one has a case of it on hand he is anxious to know at once what to do. The writer has noted that in years when he has had trouble from bloat on his alfalfa, his neighbors have had as much trouble and more loss from bloat on their red

clover, and what is good treatment for one instance is for the other.

Alfalfa Dangerous After Frost.—There is a time when succulent alfalfa may be frosted and afterward become very indigestible and dangerous to pasture off green; in fact, not the best food when made into hay. It is therefore a safe rule to take all stock off the alfalfa pastures after a hard frost at once and for the rest of the year. It is well to leave a growth of twelve inches to catch the snow and protect the crown and the greatly increased yield the next year will much more than offset the small loss from not eating every bit of the crop in the fall.

Mixing Grasses With Alfalfa.—Reference has previously been made to the value of grass mixed with alfalfa pasture when it is to be grazed, and in my experience certain alfalfa fields that have in them considerable bluegrass and brome grass have never given one case of bloated stock. Alfalfa sown thinly is also much less apt to bloat stock.

Grazing Spring Lambs on Alfalfa.—I have for some years made a practice of growing winter lambs. All the ewes would not yean early enough to get their lambs off on the early markets, so those born in March and April would be left to go to pasture. It has been my practice to put these ewes and their lambs on alfalfa pasture about the first of May, some years a few days later, and feed the lambs ear corn in creeps. These lambs have made astonishing growth thus treated, averaging above

80 pounds in June, and the ewes without grain have fattened while suckling their lambs. Lambs eating corn and suckling their mothers have never suffered from bloat in my experience.

Grazing Pigs on Alfalfa.—Alfalfa is the natural food for swine. The pregnant sow on alfalfa pasture generally needs no grain at all, at most but a trifle of corn should she be in a thin condition when turned to pasture. Pigs born from sows pasturing alfalfa are unusually fine and strong. After they come the sows need a little more grain than before and suckle profusely. The little pigs enjoy the sweet, tender herbage and thrive on it, but they too should have a daily allowance of grain. This is not absolutely necessary, as in Colorado, Western Kansas and Nebraska many hog ranches are found where no grain is produced or fed winter or summer, only alfalfa hay dry in winter and alfalfa pasture in summer, but the pigs are often sold to farmers in the cornbelt to be fattened. It is economy to feed corn on alfalfa pasture. Alfalfa alone is too one-sided a ration; it is too rich in protein and too poor in starch and fat. It builds the pig long and lean unless corn is added, but the amount of corn should be very much less than is needed on other pasture. In Kansas the state agricultural college has found that "at this station, pigs were pastured throughout the summer on alfalfa with a light feeding of corn. After deducting the probable gain from the corn, the gain per acre from the alfalfa pasture was 776

pounds of pork. One lot of fattening hogs was fed all the corn they would eat, another lot all the grain and dry alfalfa hay they would eat. The lot having alfalfa hay made a gain of 868 pounds of pork per ton of alfalfa hay."

Pasture for Horses.—There is nothing else so good for horses as alfalfa pasture. Working horses keep in good flesh and work well, with a trifle of grain added to their daily run on alfalfa; especially is it good for mares and their foals. The mares give a great abundance of milk when having alfalfa green and the colts make a growth and development that is surprising. When visiting the great ranches along the Sacramento and San Joaquin Valleys in California, I was constantly astonished at the size and quality of Thoroughbred and standard-bred horses and colts running on alfalfa pasture in summer and wintering on alfalfa hay. There is such an abundance of flesh and bone-forming material in alfalfa that colts develop naturally and to their utmost when fed upon it. No ill results whatever have ever been observed by myself from depasturing alfalfa by horses, though I would not put them on it too early in spring nor when too hungry.

As a Bee Pasture.—In California, Nevada, Utah and Colorado, alfalfa honey is a staple article of commerce. I have seen some marvelous things in the way of alfalfa-fed bees. At Gov. John Sparks' ranch, at Reno, Nev., the bees took possession of the space between the weatherboarding and the plaster

of the dwelling. From this they were dislodged from time to time and robbed, at one time yielding near a ton of honey. At the Chowchilla ranch, near Merced, Cal., bees inhabited a hollow wall of a granary and their store yielded 3,000 pounds of honey at one time. Stranger still, in the peak of the roof of a farm building there hung pendant a mass of comb and honey at least twelve inches thick and eight feet long, hanging down three feet or more. This was about to be removed for fear it would fall of its own weight.

In Colorado, the production of honey has fallen somewhat in the sheep-feeding district, since alfalfa has been cut earlier, before it has come much into bloom. This fact of necessary earlier cutting will prevent the bees making so much use of alfalfa in the east as they do in the pastoral regions of California.

Experiments made by the Kansas experiment station showed that bees were very necessary to the development of alfalfa seed. Whether there may not be other insects than the honey-bee that assist in this work is a question yet to be definitely determined. It is certain that alfalfa seed is abundantly produced only in dry seasons. Possibly in dry seasons there is more honey in the blooms and therefore more to entice the bees.

Alfalfa for Cattle Grazing.—Reference has been made already to the practices of ranchmen in California where it is not uncommon to see thousands

of cattle grazing on rich alfalfa pastures. There is little bloat among these cattle, partly because of the presence of annual grasses in the alfalfa and partly because of the system of management. It is a custom with these ranchmen when bringing hungry cattle to an alfalfa field to mow down a block of about 40 acres, turning the cattle in as soon as it has wilted somewhat. When once the cattle are stuffed full of the half-dry alfalfa hay they are permitted to begin eating the green stuff, and will, it is said, eat alternately of the green and the dry. Or sometimes they are turned in a field that has been all mown down and eat of the dry till the green comes up through, when they eat of whichever they choose. The losses of Henry Miller, who annually pastures many thousands of cattle on alfalfa, are reported to be less than 1% from all causes, bloat included.

The danger of bloat increases according to region. There are places where cattle bloat badly, other places where there is little if any bloat from feeding off green alfalfa. The reason for this is not understood. It is certain that pastures containing a mixture of alfalfa and grass are much less dangerous than those composed of pure alfalfa.

ALFALFA IN SOUTH AMERICA.

It is in South America that alfalfa grazing has reached its greatest development. From the special report of Frank W. Bicknell to the United States Department of Agriculture in 1904 and from letters I summarize the following information:

Alfalfa has redeemed to profitable use millions of acres of Argentine land that would otherwise be unproductive. Alfalfa sends the Argentine steer to market a year younger than when the native grasses were relied upon exclusively. In many parts of the country, especially in the north, it has made money for the small colonists or farmers who have cut it and sold it for export or for domestic use. Cattle raisers have learned its value in a dry cold winter when the pastures have failed, and but for the alfalfa hay, put up by the provident against such an emergency, hundreds of thousands of cattle would starve.

It is the ambition of nearly every ranchman or estanciero to get as much of his place into alfalfa as possible, and the area of pasture is increasing enormously every year. As soon as a brief experiment demonstrates the adaptability of a new region to alfalfa there is a grand rush to get in and land jumps up incredibly in value. Thousands of acres often change hands several times in a year with valuations doubling at each exchange.

John Benitz went to Argentina from California 35 years ago and with his brothers has been successful with alfalfa and cattle. On their home ranch La California, about 70 miles northwest of the city of Rosario, they were the pioneers in the planting of alfalfa. He now (1904) is working about 60,000 acres of alfalfa in southern Cordoba. He says: "You can buy a league (6,672 acres) of virgin land for $11,000 or $1.65 per acre, and by spending as much more in putting it in alfalfa have a ranch that will carry 3,000 cattle and keep them practically fat all the year round, with very little risk from drought or severe winters."

The seasons are reversed in Argentine, so that sowing in the fall they sow in March or April usually. Sometimes it is sown later with some cereal, usually

barley, wheat or flax, sometimes with maize, uncultivated. The fall seeding (March or April) is best when a seedbed can be prepared, but Argentine summers are dry and hot and it is difficult to get large areas in good condition before rains fall. Therefore much alfalfa is not sown till June or July (midwinter with them) when rains have come and it is sown with wheat or some other cereal. It requires more seed when the nurse crop is used.

This seeding with wheat seems so successful that it is worth experiment in our Southern states, where a similar proceeding might result as well if the soil were made rich and filled with lime, both of which conditions prevail in Argentina. Of this practice in Argentina an Englishman, Mr. Glyne Williams, who ranches about 300 miles south of Buenos Aires, wrote in May, 1903:

Last year I harvested 30 bushels of wheat to the acre on a piece where this year I have very good alfalfa. * * * The advantages of sowing with wheat are obvious in the saving of another plowing, and, far more than this, in the saving of time. * * * Until I see more decided advantages than I do at present in favor of sowing alone I intend to continue sowing with wheat, so long as the latter remains a paying crop. As far as my experience goes there is no objection to grazing alfalfa with cattle while it is young. To do so with sheep and eat it bare would, I think, be dangerous as they crop it too closely.

John Benitz, already quoted, thus records his experience:

I have had the best results by breaking up virgin camp in the fall or spring and at once cross disking, harrowing and sowing with alfalfa alone and covering it with a lighter harrow. Alfalfa so sown can be stocked with cattle two or three months

after sowing, fed down close and tramped. Then the stock should be taken off for a few months and the alfalfa will grow splendidly. If alfalfa and wheat are sown together cattle can not be put on till a year after, but if sown alone cattle can be put on permanently when it is six months old.

The opinion seems general in Argentina that more or less feeding is good for alfalfa when it is young, certainly by the time that it is five or six months old as the tramping is beneficial, and the plants should not seed the first year. Sometimes it is grazed with sheep, a shepherd keeping them moving so that it will not be grazed too closely. They do a good job of weed eradication and also tramp the land well. In the spring it is not possible to put on stock enough to keep the alfalfa down because it grows so fast and the arrangements for watering the cattle are not sufficient for the numbers that would be required. Mr. Williams, already quoted, had at one time two head of cattle to the acre and was at the same time cutting some for hay from the same field. Later in the season when the weather became very dry the alfalfa would keep fewer, or no animals for a time, then recourse would be had to stacks.

Seeding in Argentina.—From 9 to 35 lbs. of seed per acre are used, usually from 11 to 18 lbs. Seed is harvested plentifully in many parts of Argentina. In some places the alfalfa is allowed to re-seed itself. The usual price is from $3.50 to $8.00 per bushel (60 lbs.).

Life of Argentina Alfalfa.—It is said that in some parts of Argentina alfalfa will endure for 25 years

when mown. On the other hand, close feeding and hard seasons will destroy its value in about three or four years. Native grasses come up in it and ultimately weaken it. In some colonies, notable upper Santa Fe, it is more permanent. There at the Jewish colony there are fields 15 years old yet in fine condition. The climate there is hot, with dry summers.

It is a curious commentary on the absurd relation between what the farmer gets and the consumer pays that in Buenos Aires alfalfa hay retails at about $10 to $15 per ton, the freight, baling, hauling and commissions absorbing the difference between that and the $2.40 that the rancher receives.

Corn also is being increasingly grown and fed in Argentine. The beef is all killed and frozen there, exported then mostly to England. Good steers are worth around $30 to $60 each. Feeders, about two years old, are bought for from $8 to $12 per head, very thin in flesh, and placed on alfalfa pasture for six to ten months or sometimes a little longer.

Cattle Carrying Capacity.—Alfalfa never does less than double the capacity of pastures however rich they may be. Often it multiplies the capacity of the pasture from three to six times. In some parts 3,000 cattle are being fattened on one league (6,672 acres) of land, and another thousand or more might be added if breeding cattle were carried. Once these camps would carry only about 800 cattle to the league.

It is found impossible to cut as much alfalfa as

ought to be cut because of the immensity of the fields and the dearth of labor. It is best there, as elsewhere, to mow and stack the surplus, letting the new growth come up strong and fresh.

If there is any difficulty in pasturing alfalfa in Argentina arising from its liability to bloat animals I have been unable to discover any mention of it in reports from that country. It is probable that there is some loss when hungry cattle are suddenly turned to rank alfalfa. Being constantly on it, and having access to native grasses more or less mixed with the alfalfa the loss is probably very slight.

Finishing Cattle on Alfalfa.—The carrying capacity of alfalfa pasture in Argentina is estimated at from 2 to 4½ animals per square (4.17 acres) the year round, or in round numbers from ¾ to 1 animal per acre. An animal there always means a beef animal, and it is estimated that a pasture will carry four times as many sheep as it will cattle. This is a curious estimate as it is usual to estimate 8 sheep to one steer. This estimate is for breeding cattle. For fattening it must be reduced slightly. Except in the winter alfalfa pasture will fatten three to five rough animals per square, in five to eight months. Rough, thin work oxen are fattened in that time. There is a large business of raising feeders on poorer lands north or south on native grasses and driving them in great herds to the alfalfa fields to be fattened. As the beasts approach within a few months of the age at which they should start

for market they are shifted about from one pasture to another and are given the best on the place. At other times they are not moved much but are left in one large pasture sufficient for their needs for a year.

In the summer much alfalfa is allowed to go to waste because it is not always practicable to put on enough cattle to eat it all, as there would not be feed enough in the winter. Some cutting of pastured alfalfa is often done. After the first spring growth has been eaten down the cattle are taken away for a few weeks, and hay is put up, with a temporary fence around the stacks. In winter when feed gets short these fences are often taken away and cattle allowed to help themselves, though some ranchmen practice a less wasteful method of feeding.

These ranchmen have learned by experience that the alfalfa will be better in the winter and will live longer if it is not eaten down closely in the summer but is allowed to grow to its full height.

The following estimate of cost of making alfalfa hay in Argentina gives clue to labor conditions and wages down there. The estimate is from the Jewish colony at Mosesville, 100 miles northwest of the city of Santa Fe:

Price in stack, per ton		$2.40
Cost of mowing with machine	$0.36	
Raking, gathering, stacking	0.71	
Total cost of making hay		$1.07
Net profit per ton		$1.33

ALFALFA FOR THE SILO.

The question is often asked: "What of alfalfa silage?" The answer is that it makes good silage, if it is put into the silo in the right condition, and the silo is a good one. It is not always wise to make silage of alfalfa rather than hay. Corn makes good silage. Corn is easily grown on alfalfa sod. Corn is needed to balance alfalfa. Corn is somewhat cheaper to handle and put into the silo, perhaps, although there are conflicting opinions here. Alfalfa is easily cured in most countries, and where corn silage is fed there is need of dry alfalfa hay. So as a rule I advise that alfalfa be made into hay and corn (maize) made into silage. We do not know all about alfalfa silage yet. I have made it, accidentally, in the stack, and can testify that the cattle relished it. I have seen it made in California, where it was desired because the fermentation softened the barbs on the accompanying foxtail grass, and I have seen more or less of it in various sections.

Conditions of Silage Making.—The present state of information seems to be that alfalfa should be in full bloom before being cut for silage. Immature alfalfa is liable to become acid and have disagreeable odor and taste. It should get fairly mature and be cut with the dew on and raked and hurried to the silo. The first crop is best. It ought to be

cut in short lengths as it packs better and keeps better. It is good food for cows, calves and pigs. It is by some especially recommended for pigs.

Steam Cured Silage.—Perfect silage could probably be made from alfalfa by the steam curing process. This consists of filling the silo and immediately turning into the center of the mass, low down, a volume of steam. Steam continues to enter until all the silage clear to the top is of a temperature of about 212°. In making silage by this operation the bottom of the silo should not be concrete as much moisture will come from the condensing steam.

Silage in Rainy Regions.—Men have reported cutting alfalfa while rain was falling, raking and putting it directly into the silo with good results. The chief hope of the silo for alfalfa is for regions where there is excessive rainfall at time when the first crop should be cut. In Louisiana and Mississippi one finds these conditions.

In passing it may be mentioned that in silo building only good silos are worth considering. Those of concrete are cheapest in the long run, and silos of thin concrete walls, well reinforced with steel, then coated on the inside with pitch or black asphaltum paint till they have a glossy surface, keep silage exceedingly well.

BALING ALFALFA HAY.

A few men report success in baling alfalfa right from the windrow or cock in the field, then piling it loosely in such manner that air circulates freely between the bales. Most experiments with baling alfalfa hay from the field have been unsuccessful.

To cure the hay in the field as well as one can, then to stack or put in the mow for a month, or till it has gone safely through its sweat, is the only sure way of getting hay ready for the baler.

Where a little salt has been used, say 10 lbs. to a ton of hay, the leaves will hold on a little better during the baling process.

Air Circulation.—There is a new machine making a round bale with a hole through it lengthwise. This baler is meant for use in the field. It is claimed that with this bale there is less mold than with the square bale. I hope the claim may prove well founded. Dealers prefer small bales of alfalfa.

In storing baled hay set the bales on edge, as brick are set up, and allow some space between bales so that air can penetrate. Never lay bales on the ground; have a circulation of air always under them and around them. It is said to be much better in loading cars to set the bales up edgeways, not to lay them flat, and that there will be less mold so treated.

Hay Dealers' Classifications.—The National Hay Association adopted in 1905 the following classification for alfalfa hay:

Choice Alfalfa—Shall be reasonably fine, leafy alfalfa, of bright green color, properly cured, sound, sweet and well baled.

No. 1 Alfalfa—Shall be coarse alfalfa of bright green color, or reasonably fine, leafy, of good color, and may contain five per cent of foreign grasses; must be well baled, sound and sweet.

No. 2 Alfalfa—Shall include alfalfa somewhat bleached, but of fair color, reasonably leafy, not more than one-eighth foreign grasses; must be sound and well baled.

No. 3 Alfalfa—Shall include bleached alfalfa, or alfalfa mixed with not to exceed one-fourth foreign grasses, but when mixed must be of fair color, sound and well baled.

No-Grade Alfalfa—Shall include all alfalfa not good enough for other grades, caked, musty, grassy or threshed.

FEEDING VALUE OF THE HAY.

Alfalfa has high feeding value. This arises from its digestibility and its composition. Alfalfa is rich in digestible protein. Protein is the substance in foods that goes to build red flesh and blood, to make nerve and brain. There is much bone-making material in alfalfa also. Thus alfalfa is a builder of tissue, of muscle, bone, nerve, brain. It is a food rich in nitrogen, the prime component of protein. It is because of its alliance with the bacteria that it is able to store itself so full of this nitrogen. We have no other forage so good, so rich in protein. And protein in foods is what costs. Carbon is cheap enough. We get carbon, the heat-maker, the stuff that makes fat, in corn (maize), in most sorts of hay, in alfalfa also, as it has nearly enough of carbon or carbohydrates to make it a balanced ration in itself.

Protein the Costly Food Element.—Protein we must have. Especially do we need it when we are growing any sort of young animals or making milk or farming for eggs. One can not possibly get growth or milk without protein in abundant supply in the ration. If he is dependent on corn for his chief food supply he must buy his protein. A great many farmers and dairymen are buying theirs. They buy wheat bran, about as rich in protein as

alfalfa, linseed oil meal, quite a little richer than alfalfa in protein, or cottonseed meal, richest of all, but a dangerous feed in unskillful hands. Thus they compound rations that give them good results, but the cost eats up the profit.

Substitute for Bran.—Wheat bran has increased in cost by leaps and bounds. I once bought it for $8 per ton. I then fed lambs on timothy hay and shredded corn stover, with corn (maize) for grain food. With the aid of the purchased bran, supplying the protein lacking in the other food, I made good lambs. It was a profitable business. Then other feeders found out that bran was good for lambs, the price went up, steadily higher and higher. Had not I found that I could substitute alfalfa hay for wheat bran and get just as good lambs I would have quit the business or gone bankrupt. Thousands of feeders and dairymen are on the ragged edge of bankruptcy today because of their large feed bills for purchased protein. At present wheat bran is worth about $25 to $30, almost anywhere that it is fed.

A ton of it is only better than a ton of alfalfa hay because of its being more easily eaten; there is the same nutriment in the alfalfa hay, very nearly.

Need of Protein.—Young animals almost starve for protein very often, especially where corn is cheap. I have many times seen pigs in the feedlot after cattle, having more corn than they could consume, fat, round, yet dwarfed, half-starved. Their

bodies could not grow, they could only fatten. There was not enough protein in the corn to build their frames right. To feed them more carbohydrates or fat-making material without first building their frames was sheer waste. There is wealth of material in the form of carbohydrates or fat-making, heat-making elements. What nearly all farms and feedlots are short of is the element of protein. With it in abundant supply all goes well. Pregnant animals deliver strong young, they have plenty of milk, the young grow off fast and thrifty, good form is soon grown, abundant life and spirits are seen in the animals, fat is laid on well, the health of the animals is good and if the fortunate owner does not make money it is because of some other factor of trouble entering not chargeable to the feed elements.

Bread from Alfalfa Meal.—I have already told how once when a boy I chewed alfalfa hay and found it good. It was my first hint as to the richness of alfalfa as a feed. I have no idea that in my day men will make bread of it, yet the experiments of some Nebraska college boys is interesting, and I herewith present them, as related in a daily paper:

When Nebuchadnezzar went out in the fields many thousands of years ago and ate the grass like an ox the people of those ancient days regarded him as insane. But like many other great men the Babylonian King was ahead of his time, for were he living in Omaha today he would be hailed with joy by the members of the Creighton Alfalfa Club. The young men of this organization are eating hay and getting fat on it.

Farm experts have proved that alfalfa contains several times as much nutriment as clover, and is the best forage for cattle. That it was also a food for man was never realized until ex-

periments were made at Creighton University, the leading Catholic school in the west. That alfalfa as a food has passed the joking stage is shown by the fact that more than a score of students have formed a club to demonstrate its value to the world. More than that, the housewives of Omaha have started to use it in preparing meals. Its enthusiasts say alfalfa will revolutionize the food question, and that it will solve the serious problem of supplying the world with flour a few decades hence.

The alfalfa is carefully selected, and the bright and tender leaves and a small portion of the upper parts of the stalks are ground together. Then they are run through a bolting machine that turns out a meal almost as fine as flour and having a rich brown color. The meal is then bleached. This having been done, it is ready to go to the culinary department of the college club. There it is cooked into a large number of palatable dishes.

There are alfalfa gems, and they are so tender and rich when properly cooked that they almost melt in the mouth. The most delicate muffins cannot compare with them. They are light, palatable and easily digestible. Experts who have studied their value as food say that a man can make a meal on alfalfa meal muffins and do more work and with less fatigue than he could if he had eaten beefsteak, bread and potatoes. Cakes of all kinds are made of alfalfa flour, the recipes being similar to those employed in the construction of the cakes in which wheat flour plays the leading part. For every day bread alfalfa flour has been tried at the club. It is darker than wheat flour. The taste is most delicious, being a little sweet, and is much more palatable if a little sugar is added to the dough before it goes into the baking pans. In making bread, yeast is used in about the same proportions as in the manufacture of the bread made from wheat flour.

It may be that the day will come when we will cease eating animals and when that day comes we may possibly take to alfalfa meal; at present it is a matter of some interest to know that alfalfa is actually rich enough to make food for mankind. This ought to give us a clue to several important facts. One is as to its value in nourishing animals, the other that one can feed it in too liberal and wasteful amounts. Horses, for instance, can con-

sume more alfalfa than they need and more than is good for them. Were the alfalfa made into loaves of bread no one would dream of filling a horse's manger full of these loaves, yet it is all too common to stuff them with alfalfa hay.

CHEMICAL COMPOSITION.

Before presenting tables of exact composition of alfalfa let us consider its relation in productivity of nutrients as compared with other common feed stuffs. The following table is from a bulletin of the New York Experiment station at Geneva:

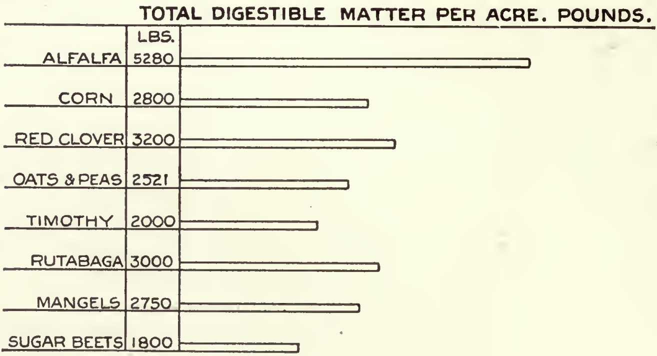
In order to show the high feeding value of the alfalfa from an acre, the average product obtained at this station during the three years past is stated in the following table in comparison with the food supplied by several of our best common fodder crops. The average of the five alfalfa crops was 34,104 pounds of green fodder, or 8,035 pounds of dry matter, containing 1,411 pounds of protein, 1,103 pounds of this being albuminoids:

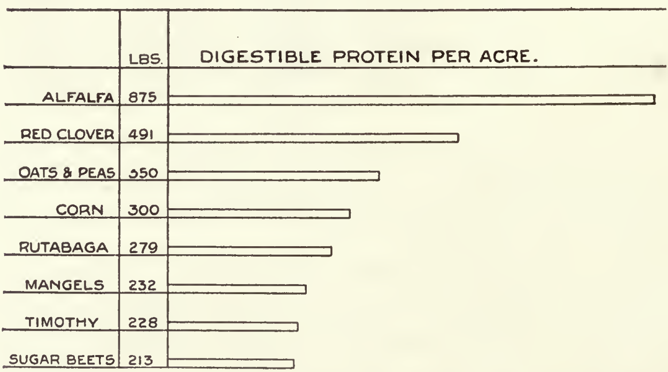
	Yield per acre of total crop.	Dry matter per acre.	Total digestible matter per acre.	Digestible protein.
Alfalfa	34,100 lbs.	8,000 lbs.	5,280 lbs.	875 lbs.
Red clover	18,000 lbs.	5,220 lbs.	3,200 lbs.	491 lbs.
Oats and peas	13,000 lbs.	3,120 lbs.	2,521 lbs.	350 lbs.
Corn, entire plant	28,000 lbs.	5,800 lbs.	3,800 lbs.	300 lbs.
Rutabagas	31,700 lbs.	3,400 lbs.	3,000 lbs.	279 lbs.
Mangels	25,000 lbs.	3,500 lbs.	2,750 lbs.	232 lbs.
Timothy	10,000 lbs.	3,500 lbs.	2,000 lbs.	228 lbs.
Sugar beets	17,800 lbs.	2,500 lbs.	1,800 lbs.	213 lbs.

The acreage yields of the several crops given above are such as have been secured at different places in this part of the country from Pennsylvania to Canada. Sometimes considerably larger crops have been obtained, but the average crop would be less than any mentioned in the table.

This is indeed a wonderful showing. More carbohydrates than corn and nearly three times as much protein! And the crop of alfalfa, once the field is established, can be grown and harvested at much less expense than the corn, while corn impoverishes land on which it grows and alfalfa enriches it.

In order to illustrate this relative production of digestible matter more graphically we present two charts showing clearly the proportions of total digestible nutrients and digestible protein in each crop:





Kansas Experiments.—J. T. Willard, of the Kansas experiment station, has done most interesting work in investigation of the nutritive qualities of al-

falfa and also of the loss of nutritive properties through exposure to the weather. We quote him from Bulletin 155:

COMPOSITION OF ALFALFA HAY.

	Water.	Ash.	Crude protein.	Pure protein.	Crude fiber.	Nitrogen-free extract.	Crude fat.
First stage, about ten per cent in bloom........ ..	8.77	9.54	16.88	13.56	29.38	34.01	1.42
Second stage, about one-half in bloom............	7.71	9.49	15.88	12.63	31.44	34.23	1.25
Third stage, full bloom....	8.29	7.75	13.23	10.62	33.11	36.34	1.30

As the amounts of moisture present in a hay are variable and not a characteristic of the stage of maturity of the green plant, a calculation of the results to a water-free basis is often advantageous in making comparisons. Doing this for the three samples of alfalfa hay we get the following:

COMPOSITION OF ALFALFA HAY CALCULATED TO A WATER-FREE BASIS

	Ash.	Crude protein.	Pure protein.	Crude fiber.	Nitrogen-free extract.	Crude fat.
First stage................	10.45	18.50	14.86	32.20	27.29	1.56
Second stage	10.28	17.21	14.18	35.37	34.00	1.05
Third stage................	8.45	14.43	11.58	36.10	39.62	1.41

Without going into the details of a discussion of the characteristics of the groups of feed principles named in these tables it may be useful to remind the reader of certain elementary facts.

The ash of a feeding-stuff is the residue left after burning all combustible substances. For the most part this is derived from the soil, though it may contain carbon that was secured from the carbon-dioxid in the air.

The crude protein embraces all organic compounds containing nitrogen and may even include some inorganic nitrogenous substances.

The pure protein is the crude protein minus certain nitrogenous substances that are less complex than proteins proper, and possess a lower food-value. The proteins, by reason of the nitrogen, sulphur and phosphorus which they contain, are entitled to greater esteem in a feed than are fats and carbohydrates.

The crude fiber consists of cellulose and substances more or

less like it chemically. The toughness and firmness of forage plants depend largely on this constituent. Cotton and linen are nearly pure cellulose. Obviously the crude fiber is of inferior nutritive value; indeed, there is good reason to believe that in many cases such of it as is digested by animals is utilized at an expenditure of more energy than is yielded by the digested fiber.

The nitrogen-free extract includes starch and the sugars as well as other less well known carbohydrates. In some tables this group is listed as carbohydrates, without due regard, however, for the fact that the cellulose of the crude fiber is a carbohydrate.

The crude fat extracted from hay, or from other materials, obtained by drying the green parts of plants, includes some chlorophyl, the green substances of leaves, and other compounds that are not fats, as well as any fat in the feed.

The water of a feed possesses no nutritive power and is not different from water taken by drinking.

Studying now the table showing the percentages of the several constituents of the water-free hay, it will be seen that there are progressive changes as the plant becomes more mature. It must not be supposed, however, that there is an actual decrease in the total amount of any food principle in the crop, but only that as maturity takes place certain constituents are produced in greater proportion, thus adding to their percentage amount while correspondingly reducing the percentage of the constituents produced at a slower rate.

The hay produced by cutting when the alfalfa was about ten per cent. in bloom is seen to be richer in ash, protein and fat than that produced by later cuttings, while the crude fiber and the nitrogen-free extract increase in percentage as the plant matures. The especially valuable protein is present to an extent more than one-fourth greater in the hay made at the first stage than it is in that made at the third stage, while the questionable crude fiber is more abundant in the later stages.

Digestibility of Alfalfa.—While it is true that a certain residue of indigestible matter is necessary for animals, and especially for ruminants, which are accustomed to bulky feed, we seldom need to give attention to this in practice, as feeds are ordinarily excessively supplied with such indigestible substances. Quite the reverse, we are justified in prizing more highly those feeds which show a high degree of digestibility. A proper appreciation of alfalfa hay thus requires consideration of its digestibility.

The digestibility of the hays referred to was ascertained and the following table shows the results. It gives the percentages

of the several constituents of alfalfa hay digested, first crop, three stages of growth, calculated to water-free basis:

	Ash.	Crude protein.	Pure protein.	Fiber.	Nitrogen-free extract.	Crude fat.	Total.
First stage	6.69	14.51	11.94	14.51	28.52	0.98	65.21
Second stage	5.78	12.89	9.90	17.11	26.96	0.42	63.16
Third stage	5.16	11.37	8.57	17.43	30.72	0.75	65.43

Here it is seen that the digestible protein diminishes markedly as the alfalfa matures, while the digestible carbohydrates increase. A calculation of the nutritive ratio in each case brings out this fact in a concise way. The nutritive ratio of a feed is the ratio of the energy of the digestible nitrogenous substances to the energy of the digestible non-nitrogenous substances. Making the necessary calculations, the nutritive ratios are found to be as follows: First stage, 1 to 3.11; second stage, 1 to 3.49; third stage, 1 to 4.38. These are all narrow ratios but widen as the alfalfa matures.

A full appreciation of the feeding value of alfalfa cannot be had without comparisons with other feeds. The average percentage of digestible constituents in certain well known feeds is shown in the following table:

FEED.	Protein.	Carbohydrates.	Fat.	Nutritive ratio.
Corn	7.14	66.12	4.97	1:10.8
Oats	9.25	48.34	4.18	1: 6.2
Wheat	10.28	69.21	1.68	1: 7.1
Bran	12.01	41.23	2.87	1: 4.0
Shorts	12.22	49.98	3.83	1: 4.8
Timothy hay	2.89	43.72	1.43	1:16.2
Red clover	7.38	38.15	1.81	1: 5.7

It will be seen that alfalfa cut at the first stage gave a hay that had a higher percentage of digestible protein than any of the feeds named in the table, and that the digestible carbohydrates (fiber plus nitrogen-free extract) of alfalfa compare favorably with those in the feeds cited, and in some cases exceed them. The nutritive ratios bring out clearly the value of alfalfa as a source of protein, and its great availability in balancing rations.

Many analyses of alfalfa made at other experiment stations, with such digestive experiments as have been performed, show the same general results as are exhibited in the foregoing. The earlier cuttings are richer in protein, but a high and nearly

equal degree of digestibility for the protein present is possessed by all cuttings, so that their relative feeding value is practically indicated by their composition. Nearly three-fourths of the protein of alfalfa and about sixty per cent. of the carbohydrates are digestible.

Composition of the Different Parts.—The statements made thus far apply to hay from the entire plant. It is, however, well known that there are great differences between the stems and the leaves. The most detailed analyses in this connection have been made at the Utah station. From a mass of data concerning cuttings made at different dates and upon different crops, those concerning the first crop, cut in the early bloom, have been selected and placed in the tables shown below. The first one shows the yield of dry matter in pounds per acre, and also the weight of the stalks, leaves and flowers separately. It also shows the composition of each of these parts and of the whole plant:

PART OF PLANT.	Yield, per acre, pounds.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Stalks	28.38	9.01	10.74	42.17	37.14	0.94
Leaves	18.56	14.33	24.05	13.81	41.82	5.99
Flowers	1.36	10.56	26.18	15.58	46.00	1.68
Whole plant	48.31	11.10	16.30	30.53	39.23	2.92

From the above table we see that the leaves and flowers are far richer in protein than are the stalks, while the reverse is true in respect to fiber. Nitrogen-free extract does not show so great a difference but the stalks are notably inferior. In the next table the data are presented in a different form. It shows percentages of ash, protein and fiber in each of the different parts of the alfalfa plant, to total amount of that constituent in entire plant:

PART OF PLANT.	Yield, per cent.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Stalks	58.75	47.69	38.73	81.17	55.68	19.03
Leaves	38.43	49.62	56.74	17.39	41.01	79.34
Flowers	2.82	2.69	4.53	1.44	3.31	1.63

The above table shows that of the total yield 58.75 per cent. is in stalks, but that of the total protein only 38.73 per cent. is in them, while they contain over 81 per cent of the total fiber. On the other hand the leaves, constituting but 38.43 per cent. of the yield, contain 56.74 per cent. of the protein of the entire

crop and only 17.39 per cent of the fiber. The nitrogen-free extract is not so disproportionately divided between the stalks and the leaves. Over four-fifths of the fat is furnished by the leaves and flowers, though they make up but little over two-fifths of the weight. We see from this the exceeding importance of so handling the crop as to preserve the leaves and flowers. By the loss of all of these the feeding value will be impaired much more than the loss in weight would indicate.

Loss by Weathering.—It is apparent to all that alfalfa hay is greatly damaged by rain. This is due not only to fermentations that may accompany the process and to mechanical losses, but also to the fact that soluble substances are dissolved out and removed. Observations have been made by the Colorado experiment station upon a hay which was exposed in the field for fifteen days, during which time it was subjected to three rains, amounting to 1.76 inches. The following table shows the percentage composition of the damaged and of the undamaged hay:

	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Original	12.2	18.7	26.5	38.7	3.9
Damaged	12.7	11.0	38.8	33.6	3.8

The above figures as given show that the damaged hay is considerably inferior to the undamaged, but like many other percentage statements is liable to be misunderstood, or at least not completely understood. It must not be supposed that the protein and nitrogen-free extract have been converted into crude fiber, although the damaged hay contains nearly 39 per cent. of crude fiber, where the undamaged hay had 26.5 per cent.; at the same time the protein and nitrogen-free extract are present in much smaller quantity in the damaged hay. The facts are that undoubtedly portions of all these food principles have been lost from the crop as a whole, but that the protein and the nitrogen-free extract have suffered much more proportionately than the crude fiber, this being almost insoluble and not subject to rapid fermentation.

A much more instructive view of the actual losses is obtained by additional calculations. The loss sustained by the alfalfa naturally fell most heavily upon the soluble and more easily decomposed substances. The most resistant of the constituents was the fiber, which probably suffered but little. Taking the crop as a whole then there would be as much or nearly as much fiber as there was before, excepting that which was lost

mechanically. We may use this figure as a measure of the minimum losses by others. In every 100 pounds of the original hay there were 26.5 pounds of fiber, and after it was damaged there could not have been any more, and in fact there must have been less. If we make the most favorable assumption, viz., that there was no loss of fiber, then the 38.8 per cent. of fiber in the damaged hay is really the fiber that was 26.5 per cent. of the original hay. The apparent increase in the percentage is due entirely to the loss of other constituents. The figures representing the percentages of the other constituents as given above are all correspondingly too high for comparison with the percentages of those constituents in the original hay. In the following table the weights of these constituents accompanying 26.5 pounds of fiber in the damaged hay have been calculated. These are to the percentages of those constituents in the damaged hay as 26.5 is to 38.8:

	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.	Total.
Original	12.2	18.7	26.5	38.7	3.9	100
Damaged	8.7	7.5	26.5	23.0	2.6	68.3
Pounds lost	3.5	11.2	....	15 7	1.3	31.7
Per cent lost	28.7	60.0	....	41.0	33.3	31.7

Comparing these figures, it will be seen that of the original 100 pounds of hay only 68.8 pounds remained; that 60 per cent. of the protein was lost, one-third of the fat, and 41 per cent. of the nitrogen-free extract. As the assumption in reference to fiber was more favorable than the facts, so this calculation in respect to protein, fat and nitrogen-free extract gives figures that are more favorable than was actually the case.

Startling as the losses indicated by the preceding calculations are, the actual damage is even greater than is indicated by them. Since the materials lost obviously consisted of the most soluble and easily decomposed parts, and hence the parts most easily digested, a smaller percentage of the protein remaining was digestible in all probability than would have been the case with the protein that was lost. It is quite reasonable to assume that one-half of the feed values of the crop had been lost from an exposure to rain that was not excessive in quantity and fell in three different showers.

Westgate's Bulletin.—From J. M. Westgate's admirable bulletin (Farmers' Bulletin 339, Department

of Agriculture) we extract the following useful and instructive tables:

AVERAGE PERCENTAGE COMPOSITION OF ALFALFA AND OTHER FORAGE CROPS.*

KIND OF FORAGE.	Number of analyses.	Water.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether extract (fat).
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Fresh alfalfa..	23	71.8	2.7	4.8	7.4	12.3	1.0
Fresh clover..	43	70.8	2.1	4.4	8.1	13.5	1.1
Alfalfa hay...	21	8.4	7.4	14.3	25.0	42.7	2.2
Clover hay....	38	15.3	6.2	12.3	24.8	38.1	3.3
Timothy hay..	68	13.2	4.4	5.9	29.0	45.0	2.5
Cowpea hay..	8	10.7	7.5	16.6	20.1	42.2	2.2

*In part from Henry's "Feeds and Feeding," Appendix.

AVERAGE PERCENTAGE OF DIGESTIBILITY OF ALFALFA AND OTHER FORAGE CROPS.

(Experiments with ruminants.)

KIND OF FORAGE.	Number of experiments.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether extract (fat).
		Per cent	Per cent	Per cent	Per cent
Fresh alfalfa........	2	81	45	76	52
Fresh clover........	2	67	53	78	65
Alfalfa hay.........	28	73	43	66	54
Clover hay..........	46	55	49	69	53
Timothy hay........	26	48	52	63	57
Cowpea hay	2	65	43	71	50

DIGESTIBLE NUTRIENTS IN ALFALFA AND OTHER FORAGE CROPS.

KIND OF FORAGE.	Dry matter in 100 lbs.	DIGESTIBLE NUTRIENTS IN 100 LBS.		
		Protein.	Carbohydrates.	Ether extract.
Fresh alfalfa.........................	28.2 lbs.	3.9 lbs.	12.7 lbs.	0.5 lbs.
Fresh clover.........................	29.2 lbs.	2.9 lbs.	14.8 lbs.	0.7 lbs.
Alfalfa hay	91.6 lbs.	11.0 lbs.	39.6 lbs.	1.2 lbs.
Clover hay	84.7 lbs.	6.8 lbs.	35.8 lbs.	1.7 lbs.
Timothy hay.........................	86.8 lbs.	2.8 lbs.	43.4 lbs.	1.4 lbs.
Cowpea hay..........................	89.3 lbs.	10.8 lbs.	38.6 lbs	1.1 lbs.
Wheat bran..........................	88.1 lbs.	12.2 lbs.	39.2 lbs.	2.7 lbs.
Shelled corn	89.1 lbs.	7.9 lbs.	66.7 lbs.	4.3 lbs.

The following table indicates the actual feeding value of eight different kinds of feed, based on the amount of digestible nutrients contained in them. These values are calculated from the figures given in the table just preceding. The values per pound assigned as the basis of calculation are protein, \$0.0674; carbohydrates (starches, etc), \$0.0064; ether extract (fats), \$0.0112. These figures are merely relative, as the prices of the

food elements vary in the different sections and from year to year. It will be noted that the value of alfalfa hay is slightly more than double that of timothy.

ACTUAL FEEDING VALUE OF DIFFERENT FEEDS BASED ON AMOUNT OF DIGESTIBLE NUTRIENTS.

Feed.	Value per ton.
Fresh alfalfa	$7.00
Fresh clover	5.96
Alfalfa hay	20.16
Clover hay	14.12
Timothy hay	9.80
Cowpea hay	19.76
Wheat bran	22.80
Shelled corn	20.16

ALFALFA FOR HORSES.

The place of alfalfa as a horse feed has not yet been settled beyond dispute. Most men who have not used it are opposed to its use and bring forward very good arguments against it. On the other hand in alfalfa-growing countries are found some of the best developed and most healthy and useful horses in the world. I have seen in the alfalfa pastures of California wonderful young horses, weanlings and foals, that never ate any other food than their mother's milk and alfalfa, with what little wild grass might be mixed through the field. These colts running all summer on the alfalfa meadows and being fed alfalfa hay during winter reach a magnificent development and are often as large and well finished at two years as they would be at three in a land where they ate timothy hay instead of alfalfa.

In France quite a little use of alfalfa is made in the horse breeding districts and has been from time immemorial. In England always, so far as history tells, progressive farmers have grown alfalfa and fed it green in summer time.

Personal Experience.—The writer has had experience with seeding alfalfa to horses since 1887. He began it on the Utah ranch and has continued it on Woodland Farm in Ohio since his return. In Utah the horses were most of them used under the

saddle. The country was extremely rough and the going bad. A horse must have endurance, speed, bottom. It is charged that alfalfa makes a horse soft, lacking in endurance, sweating easily. There is truth in the charge; we will explain it later. The fact is no horses could have worked better under the saddle than did these alfalfa-fed range horses. They had no other hay and for grain they had corn; we had nothing else for them.

And yet it is true that the horses worked best when they were worked regularly and worked hard. If they were idle for a long time, meanwhile eating much alfalfa hay, they did get soft and sweated considerably when suddenly put to work. I do not attempt to explain this fact. I think that the reason is that the idle horses ate too much alfalfa hay, took into their systems several times as much protein as their bodies needed or could use, and thus induced some sort of unhealthful condition of the body cells. It did not take them long to get hard under work. But it is assuredly true that idleness and excessive alfalfa feeding will make a horse soft. Idleness and six eggs a day will make all sorts of things wrong with a man, for that matter.

That alfalfa will develop a hard horse is evidenced by the fact that not a few splendid race horses have been developed in California and elsewhere on a diet almost altogether composed of alfalfa hay and pasture.

No Heaves nor Colic.—At Woodland Farm for

many years no other hay has been in use. In truth the horses refuse to eat timothy hay, having become accustomed to alfalfa. Before alfalfa came into use there was nearly always one or more horses with heaves, but since we have had alfalfa hay we have not had one case of this disease. Colic among horses is the bane of the farmer and horseman. Once the veterinary bills were a considerable item on Woodland Farm. Now colic is a rare thing, and would probably never occur again if the men did not occasionally feed injudiciously of corn, or overfeed with alfalfa hay.

Less Grain Needed.—We have learned that very much less grain is required where alfalfa is fed, not much more than half the usual ration. Why should not this be true? Alfalfa itself is as rich, very nearly, as wheat bran, itself a good grain food for a horse. Alfalfa is nearly as rich a food as oats. Horses will do a great deal of hard work with no grain at all if they have first-class alfalfa hay, but I do not recommend this. The horse has a small stomach and not much time for masticating his food. A small grain ration with his alfalfa hay is right.

Action on Kidneys.—It has been urged that the foundation for this rumor or belief is that when a horse unused to alfalfa is fed it for the first time it does stimulate its kidneys so that there is a noticeable increase in the amount of urine voided. I think this never really injures the animal and the symptoms disappear in a short time. If al-

falfa was fed in moderation, less than the animal desired, it is not likely that it would ever so affect him. It is only nature's way of throwing off protein which has been consumed in excess of what the animal could use.

On Woodland Farm are horses that have grown up on alfalfa and have never eaten any other hay in their lives. Their kidneys are sound. They do not urinate more frequently than is normal, nor void an excess of urine. Further, their urine is clear, not cloudy nor muddy. The fact is the troubles arising from alfalfa feeding are usually experienced by men having little or no alfalfa to feed. Ask a man who really grows it and feeds it and he will almost always reply that there is no better feed for horses and no bad results arise from regular and continued feeding of it.

Alfalfa for Young Horses.—There is certainly nothing else so good for the draft colt and its mother. Here one seeks size and development. Alfalfa will surely give it. Let the mare have the run of an alfalfa field in summer with a grass lot adjoining, or have grass mixed through the alfalfa. Feed her and her colt alfalfa hay in winter and as much development can be had at two years old as will be had at three by the usual feeding of timothy hay. And there is nothing yet discovered to show that this early growth is not as good as though it came later. In truth it is certain that the later developing colt will never reach the size and conformation

that the one attains that has had the right food from the beginning, and enough of it.

Alfalfa for Brood Mares.—As to the effect of alfalfa hay on the breeding of mares, opinions differ. Alfalfa-fed mares are apt to be fleshy. It is very possible that in some instances they may become too fat to conceive well. It may be that during the breeding season the mares should have less or possibly no alfalfa hay. We need further evidence along this line. Certain it is that after the mare is safely with foal a diet composed chiefly of alfalfa is very good for her. I know of no injury that can follow feeding her alfalfa and pasturing her on alfalfa till her colt is foaled. Certainly all mares are better to work up until that time, not hard but regularly, and no pregnant animal should live a life of idleness or stagnation, nor become too fleshy.

Making Horse Hay.—I think the first cutting makes as good hay for horses as any. It ought to be on the side of over-ripeness rather than to be too green, though one can err in letting it become too woody. It ought to be well cured and put into the barn as dry as possible. Then there will be no mold nor dust on it. Alfalfa leaves and stems are free from the small hairs that abound on red clover leaves and stems. These hairs make hay dusty and irritate the bronchial passages of the horse. That is one reason why one can feed alfalfa safely and can not feed red clover so well.

Fattening Sale Horses.—Many owners of sale

stables now use alfalfa hay almost exclusively, finding that the animals gain in weight much more rapidly on an alfalfa diet than upon any other. Many eastern horse breeders who have not learned to grow alfalfa are sending their colts to be pastured in western alfalfa fields, there to develop.

Over-feeding with Hay.—R. J. Kinzer and G. C. Wheeler of the Kansas experiment station have published the subjoined observations on feeding hay to horses:

A majority of horse owners are inclined to waste hay in feeding horses, i. e., they feed more than is necessary for the maintenance of the horse and more than he can economically take care of. This is true of other kinds of hay as well as of alfalfa.

Either heavy or light horses that are doing regular steady work should not, if one wishes to feed economically, have more than one pound of hay per hundred pounds of live weight. That is, a thousand-pound horse should receive 10 pounds of hay per day and a 1,500-pound horse 15 pounds per day. A 1,500-pound horse that is doing steady work should have about 4 lbs. of hay with his morning feed, the same amount at noon, and about double the amount at night. Many horses will eat 30 or 40 pounds of hay a day if they have free access to it. If a horse is allowed to eat such quantities half of it is wasted, and if he is eating that amount of alfalfa hay it is worse than wasted, for it does the horse an injury. From two to two and a half pounds of digestible protein is all that an ordinary horse can utilize in a day, and in 100 pounds of alfalfa there are 11 pounds of digestible protein. This fare of alfalfa, if too heavily fed, is likely to cause kidney disorder, and may even be responsible for abortion in pregnant mares that are fed too liberal a ration of it. If it does not cause abortion, weak unhealthy foals will be the result.

Have alfalfa fed judiciously to pregnant mares, heavy or light work horses, and it is beneficial and should be used wherever it is obtainable, but it should never be used as the exclusive roughage. Some objection is made to it on account of causing looseness of the bowels and making the horses soft and easy to sweat. This is due to their having it in too large quantities. Alfalfa hay should be fed as part of the grain ration rather than a

roughage. If fed in this manner its use will be found very satisfactory.

I think the danger of over-feeding exaggerated, yet it is assuredly a waste to over-feed it, and it must do more or less harm to the horse. In fact it is one of the greatest lessons of modern times that mankind may increase its energy and usefulness very greatly by limiting the accustomed intake of rich nitrogenous food, taking merely what is needed to repair waste and rebuild the body, instead of taking "all it can hold," merely for the pleasure of eating.

Developing Draft Horses.—When will we cease sending to France, Belgium and Great Britain for our draft stallions? When we have wide alfalfa fields and plenty of them. There are men finding the way to produce splendid draft animals at low cost in America. J. W Robison of Kansas is growing Percherons in alfalfa pasture. It is said that his three-year-old colts average 1,700 pounds and his four-year-olds 1,900 pounds. Alfalfa is almost the only food given either mares or colts. Before foaling no grain is fed, only alfalfa hay or pasture being given, and the colts come strong and the mothers free from feverish tendencies and full of milk. Colts so developed have action and quality.

Safety of Alfalfa Pasture.—There is more or less danger in depasturing alfalfa with sheep or cattle. With horses I have never seen or heard of any trouble resulting from this practice. They seem to know instinctively how much to eat and when to cease eating. Horses are not so subject to bloat.

ALFALFA FOR CATTLE FEEDING.

Experienced men say that whatever alfalfa may or may not be adapted to it is certainly in its place as a food for cattle. It is the natural food of all ruminants. They greatly relish the taste of it. They chew it well and almost completely digest it. They are in little danger of eating too much of it. Cattle thrive exceedingly on a diet of good alfalfa hay. Many years ago the writer stacked alfalfa hay in Utah, and in winter time fattened steers on it with no grain at all. They made good beef. It would have been better, no doubt, to have fed them some grain in connection with the alfalfa hay, but grain was not to be had. The beef sold well on Denver and Salt Lake City markets in the spring. It killed well.

Alfalfa alone is better as a maintenance ration than as a complete ration, however. It is full of protein, and deficient in carbohydrates and fat. It will grow animals or maintain them beautifully. With a little grain added it will grow them and finish them at the same moment.

Trials in Colorado.—Prof. W. L. Carlyle and C. J. Griffith of the Colorado experiment station went into this matter quite carefully in 1905, comparing alfalfa hay alone and in combination with sugar beet pulp and ground corn. Unfortunately the alfalfa hay used was much below the average, being very coarse, cut too ripe presumably, and was seriously

injured in curing. With good alfalfa hay the results would have been more favorable to alfalfa feeding.

The average weekly gain of these steers was as follows:

Lot 1—Fed beet pulp, hay and ground corn (maize)........19.0 lbs.
Lot 2—Fed hay and ground corn..............................12.6 lbs.
Lot 3—Fed beet pulp and hay ....13.1 lbs.
Lot 4—Fed alfalfa hay only..................................10.5 lbs.

It will be noted that the gain was only 2.1 pounds greater when corn was fed than when alfalfa was fed alone. The cattle were fatter however and thus brought more money per pound in the market.

AVERAGE AMOUNT FEED REQUIRED FOR ONE POUND OF GAIN, AND COST OF THE SAME.

	FOOD FED.			Cost.
	Alfalfa.	Pulp.	Cornmeal.	
Lot 1	7.59 lbs.	35.45 lbs.	2.51 lbs.	4.22 cents
Lot 2	17.78 lbs.	....	3.76 lbs.	7.63 cents
Lot 3	11.89 lbs.	52.83 lbs.	....	4.28 cents
Lot 4	28.29 lbs.	....	....	7.04 cents

Here is given the data showing the amounts of the various kinds of feed required to produce a pound of live weight gain on a rather rough bunch of steers rising three years old. From this table it will be seen that in case of Lot IV it required 28.29 lbs. of alfalfa hay, below the average in quality, to produce one pound of gain. With an average lot of good feeding steers, and alfalfa hay of good feeding quality, the indications are that one pound of gain would be produced for each 25 lbs. of alfalfa hay on the average.

	Lot 1.	Lot 2.	Lot 3.	Lot 4.
Weight at beginning of experiment (lbs.)	951	968	941	968
Value at 3 cents per pound	$28.53	$29.04	$28.23	$29.04
Cost entire period, 100 days	$12.95	$13.44	$7.90	$10.39
Cost of feed for 100 lbs. gain	$4.60	$7.63	$4.29	$7.04
Cost of labor in feeding	$3.25	$3.25	$3.25	$3.25
Weight finished steer at feedlots (lbs.)	1,214	1,144	1,125	1,115
Sale weight of steer at Denver (lbs.)	1,157	1,088	1,050	1,062
Shrinkage in shipping (lbs.)	57	56	75	53
Selling price per 100 lbs.	$5.15	$5.06	$5.00	$4.73
Value at selling price	$59.58	$55.05	$52.25	$50.25
Cost of marketing	$2.15	$2.15	$2.15	$2.15
Net profits	$12.70	$7.16	$10.97	$5.44

In the foregoing table is given a complete summary showing the average of each steer in the various lots. This table contains very complete data covering the various points of comparison in the results obtained with the average steer in each lot.

The conclusions drawn are thus stated:

1. An average feeder steer two years old will make a gain of 1.5 lbs. per day on alfalfa hay alone, and will require approximately 28 lbs. of hay to make one pound of gain.

2. The addition of ground corn to the ration of alfalfa hay will increase the daily gain, increase the market price of the steer by finishing him better in a given time, and will add to the profits if the corn can be procured below 90 cents per hundred pounds.

3. A pound of ground corn is equal in feeding value to 2.8 lbs. of alfalfa hay and to 9 pounds of sugar beet pulp for feeding two-year-old fattening steers.

4. Sugar beet pulp at present prices is a cheaper and better feed than ground corn when fed with alfalfa hay for fattening mature steers.

5. That 3.22 of beet pulp is equivalent in feeding value to one pound of alfalfa hay, when fed in conjunction with the hay, giving two-year-old steers all they will eat of both feeds.

6. With alfalfa hay at $5 a ton, it will pay to feed a light ration of ground corn with the hay, provided the corn can be purchased at from 85 to 90 cents per hundred weight.

7. With poor alfalfa hay at $5 per ton, sugar beet pulp is worth $1.50 per ton to combine with hay for fattening mature steers.

8. Fattening steers will gain approximately a pound a day more on a ration composed of alfalfa hay, ground corn and beet pulp than they will on a ration made up of alfalfa hay and ground corn or on a ration composed of alfalfa hay and sugar beet pulp, and they will gain almost one and a half pounds more each day on the above ration than when fed alfalfa hay alone.

Experiments in Kansas.—Showing how alfalfa hay in the ration cheapens the cost of beef production, we quote from Bulletin 132 of the Kansas experiment station, relative to work done at the Fort Hays branch station:

A matter of this experiment of considerable interest, especially to the western farmer, is the part that the various roughages play in beef production. A ration of alfalfa hay, at $4.00 per ton,

with corn and cob meal produced 100 pounds of gain for $5.13; but when Kaffir-corn hay at $3.00 per ton was substituted for alfalfa hay, the cost of 100 pounds of gain was increased to $7.32, while with sorghum hay at $3.00 per ton substituted for the alfalfa hay the cost was increased to $9.06. In other words, one bushel of corn-and-cob meal fed with alfalfa hay as roughage produced 11.8 pounds of flesh, while the same amount of corn-and-cob meal fed with sorghum hay as roughage gave in return only 6.25 pounds of flesh; thus, a difference of 5.5 pounds, or 88 per cent in favor of the alfalfa hay ration.

Tests in Other States.—A summary of trials in beef making with alfalfa is thus presented by J. M. Westgate, of the Department of Agriculture:

Alfalfa forms probably the best roughage for fattening cattle, as its lack of bulkiness enables the animals to consume sufficient quantities for rapid gains. It is also very valuable for young growing stock before the fattening period commences.

The Utah Agricultural Experiment Station conducted an experiment extending over a period of five years to determine the quantity of beef produced to the acre from alfalfa hay cut in the different stages of maturity. It was found that hay cut when in full bloom produced 562 pounds of beef annually to the acre, while that cut in early bloom produced 706 pounds. The hay that was not cut until half the blooms had fallen produced only 490 pounds of beef to the acre. At the Nebraska Agricultural Experiment Station 2.41 pounds of beef were produced daily on a full ration of corn and alfalfa, while only 1.48 pounds were produced by a ration of corn and prairie hay.

The North Platte Substation of Nebraska has given, in Bulletin No. 105, some valuable data on the great value of alfalfa in growing and developing beef cattle. The first test compared alfalfa, prairie hay and cane in wintering calves where all lots received two pounds of grain daily per calf. During the winter-feeding period of the experiment alfalfa produced 143 pounds of gain per head; prairie hay, 76 pounds; cane, 46 pounds, and half-and-half alfalfa and prairie hay, 133 pounds, and half-and-half alfalfa and cane, 120 pounds of gain.

The year following the same cattle were wintered as yearlings on the same rations, except that no grain was fed. The alfalfa lot gained 81 pounds per head in 120 days; the prairie-hay lot lost 18 pounds; the cane-hay lot lost 64 pounds; the half-and-half alfalfa and prairie hay gained 62 pounds and the half-and-

half alfalfa and cane gained 92 pounds each. The amount of hay consumed or wasted about the racks daily per steer ranged from 18.7 pounds in the prairie-hay lot to 24 pounds in the cane lot, 20.2 pounds being eaten daily per head by the steers receiving alfalfa alone. From the fact that the half-and-half ration gave equally good gains with straight alfalfa, it would seem to be economy to use some of these cheaper roughages with alfalfa for wintering steers.

While no accurate data have been kept, it has been the common practice to winter the breeding cows of the pure-bred herd of the Kansas experiment station upon alfalfa hay and corn-stover, the alfalfa being fed in racks and the stover fed out on the pasture as much as possible. This method of feeding has kept the cows in splendid breeding condition, and the use of the stover has resulted in cheapening the cost of their maintenance from that of straight alfalfa feeding.

Results at Woodland.—On Woodland Farm the best and cheapest beef ever produced was from young cattle given all the alfalfa hay they would eat up clean, corn silage and a small ration of ear corn.

Meeting Competition.—In Argentina where alfalfa growing is assuming large proportions it is becoming a common thing to finish cattle with alfalfa hay and corn maize. Better beef is thus produced and a better price secured for it. Argentina, that young giant of the Southland, is our most formidable competitor in the business of furnishing England with bread and meat. The use of corn and alfalfa there, although already assuming large proportions, is yet in its infancy. We in America must awaken to our possibilities. We can grow alfalfa. We can grow it in practically every county in the United States, certainly with greater ease in some places than in others, yet almost any of us can grow it. We grow

corn with greater success than the Argentine. Our cattle are better. With abundant alfalfa all over our land we will be able to more than hold our own against this competition.

That is the dream of the writer, that he may hasten the day when alfalfa meadows will be common in nearly every township in the United States, mows filled with alfalfa hay, stacks standing in the fields, yards and corrals filled with good cattle, abundant supplies of manure made available, fields becoming richer rather than poorer, and country people having wherewithal to live as country people ought to live, in comfort, sending their sons to agricultural colleges and their daughters as well, both to come back to the farms and there continue the labor of soil-building, field-beautifying and home-making.

ALFALFA FOR DAIRY COWS.

Here is found best of all uses for alfalfa. Dairy cows are machines for making milk. Milk is a material requiring large amounts of protein for its manufacture. Dairy cows are machines and they are somewhat delicate machines. They require large amounts of protein, but they thrive better when that protein is furnished them in the shape of forage than if it is given them in concentrated form. One may buy protein; he can get it in cottonseed-meal, linseed-meal, gluten meal or other form, and by feeding the right amount get the proper nutrients in the feed, but that does not at all equal in effect the feeding of a ration mixed "as God mixed it"—that is, a forage such as alfalfa, delicious in flavor, rich enough, not too rich, bulky enough, not too bulky.

Stimulating Flow of Milk.—In truth there is no artificial blending of foods that will give the results that feeding alfalfa will. An illustration of this is furnished by the experience of a Pennsylvania breeder of Guernsey cattle. This man bought some alfalfa hay from Woodland Farm. After using it for a few weeks he wrote:

"Our Guernsey cows are entered in the official test for position in the advanced registry. Naturally therefore we have been feeding them as well as we knew how to feed them. Since they had your al-

falfa hay they have increased 20 per cent in their milk flow."

This man is now growing his own alfalfa, and his neighbors are learning from his example. In his region the plant was unknown until he began its culture. The secret of growing it there was the use of plenty of lime in the soil, then manure, phosphorus and mid-summer seeding.

Value to Dairymen.—There is not a dairyman living who is not at too high an elevation who should not make effort to grow alfalfa, as no one else needs it so much. He can stop the purchase of protein. He can keep cows in perfect health and vigor. He can get the most milk that they are capable of giving if he has alfalfa. And he can, and should, feed it nearly day of the year. Let him begin early in spring by cutting it green and soiling; let him feed dry alfalfa hay when pastures are too lush and there is danger of cows scouring in June; let him feed it green when pastures fail in August and September; let him feed alfalfa hay and corn silage after frost comes, or before for that matter. Thus the milk comes freely the year around, and all from feed produced on his own farm.

A Little Grain Needed.—With alfalfa and corn silage nearly a balanced ration is found. Very little grain need be fed in addition, though it is economy to feed a small amount, since cows need a little less bulk than it would take to furnish nutrients enough in alfalfa and silage alone.

Maintains Vigor.—One thing that should be well emphasized is that where alfalfa hay is fed liberally cows keep in splendid health and strength. They may be made to give as much milk by feeding other feeds. Cows will give milk liberally and be physical wrecks, and when fed on the forcing process with what must be classed as artificial foods they frequently go down in vitality so that they are prey to any sort of malady that may happen to overtake them. When fed liberally on alfalfa they give as much milk or more, they carry more flesh, they have better tone, more abundant vigor, breed better, drop stronger calves, the calves grow into better heifers and make better cows. There is nothing else so good for a dairy-bred heifer as alfalfa hay though she may need to be limited somewhat in amount if she shows a marked tendency to overmuch body plumpness.

Findings of Experiment Stations.—The New York station reports the results of feeding home-grown rations, consisting of alfalfa hay and corn silage, feeding four cows for sixty days, in comparison with a purchased feed ration for the same number of cows for the same length of time. These rations cost respectively $30.03 and $47.05, or 12.5 cents and 19.6 cents per cow per day. This is a net gain of 24.3 cents per hundred pounds, and a half of a cent per quart of milk, or a saving of 33.7 and 31.5 per cent., respectively, for milk and butter in favor of the home-grown ration. They estimate that when

purchased feeds average $25 per ton alfalfa is worth $16.50 to feed with corn silage.

At the New Jersey station a test was made with two lots of dairy cows to determine the comparative value of alfalfa and a combination of wheat-bran and dry brewer's grains as a source of protein. In this test the alfalfa ration produced a daily yield of 20.8 pounds of milk and 1.06 pounds of butter, while the bran and brewer's-grain ration produced a daily yield of 21.8 pounds of milk and 1.08 pounds of butter, only a slight difference in favor of the more concentrated protein foods. Bran and dried brewer's grains each cost $17 per ton, on which basis alfalfa hay proved to be worth $11.16 per ton.

At the Maryland station alfalfa and cornmeal gave better results than silage and commercial foods. Where alfalfa and silage were fed with and without grain, the grain feeding proved the more economical.

Experiments conducted at the Tennessee experiment station tend to show that one and one-half pounds of alfalfa will replace one pound of wheat-bran.

The New Jersey station concludes that three pounds of alfalfa is equivalent in feeding value to one pound of cottonseed-meal.

The Nebraska station compared feeding alfalfa hay with the feeding of prairie hay, and decided as a result of these tests that alfalfa produced 10 per cent more milk from 10 per cent less food.

The Utah station found that adding cornstalks to a corn and alfalfa ration gave larger returns per unit of dry matter than alfalfa without stalks.

Alfalfa Meal for Dairy Cows.—Alfalfa meal undoubtedly has advantage in some ways. It is a saving of labor for the cow to have her alfalfa ground for her. If it could be ground very cheaply no doubt it would pay. However, the Pennsylvania experiment station reports adversely on alfalfa meal, or at least that it is no better than wheat bran, if it is quite as good. It is interesting to note, however, that when wheat bran and alfalfa meal were rated at the same price per ton the cost of milk production was nearly identical. With alfalfa meal at $23 per ton and wheat bran at $20, corn-and-cob-meal at $20, and cottonseed-meal at $28 per ton, the grain cost of 100 pounds of milk when the cows were fed alfalfa was 47.1 cents; when fed wheat bran it was 45.3 cents.

Assuming alfalfa meal to cost no more than bran the former seemed to produce milk at the lower grain cost per hundred pounds—44 cents, as compared with 45.3 cents on bran. On this basis of comparison if wheat bran was worth $20 per ton, alfalfa meal was worth $21.28 per ton.

I am not sure that it would pay to make alfalfa meal for home use and to feed to cows. I incline to believe that to dampen the hay over night, restoring it thus somewhat to its natural green condition, would be cheaper and nearly as effective. Certainly

where alfalfa hay is worth no more than $10 per ton it would be cheaper to feed it unground and in large amounts.

Alfalfa Silage for Cows.—Already we have discussed the making of alfalfa silage. The experiences of men making silage of alfalfa are varied. Some like the stuff, some have indifferent success in making it. It seems certain that immature alfalfa makes poor silage. The plants should be in good state of bloom, should be cut with dew on and raked at once and hurried into the silo, well cut into short lengths with no drying. Corn for silage, alfalfa for dry feed—"it is something to chew on," it is necessary to the cow, it keeps her occupied, in health and vigor. God speed the day when millions of acres of alfalfa will lie adjacent to dairy barns all over our land.

ALFALFA FOR SHEEP.

Alfalfa for Sheep.—All sheep love alfalfa either green or dry. The very nature of the animal makes alfalfa a suitable food for it. Sheep need foods rich in protein. It takes such food to make good wool, red flesh, blood, bone, milk. Sheep are usually either young and growing or else are ewes giving milk, or pregnant and developing within their bodies unborn lambs. Growth calls for protein. Milk calls for protein. Wool calls for protein. The protein requirement of the sheep is greater than with the cow. This much for theory.

Essential to Profit.—The practical part of it is that experience has shown that sheep dearly love alfalfa, green or dry, and thrive exceedingly on it. In fact it is hard to make profit in America in sheep farming unless one has alfalfa hay to fall back upon. The best shepherds are provided with it. It is fed during winter time in the sheep folds; ewes yean on a diet of alfalfa hay; they suckle their lambs with milk made chiefly from alfalfa; they go sometimes to pasture composed of a mixture of grasses and alfalfa; the lambs are fattened on alfalfa hay and grain. The sheep industry in America with alfalfa taken away would almost collapse. Millions of sheep are fattened mainly on alfalfa hay. It is the very foundation stone of the industry.

Grazing Sheep on Alfalfa.—In another place reference is made to this practice and it is told how that alfalfa pastures destined to be fed off by sheep should have grasses mixed through them, as a preventive of bloat. The secret of successful grazing of sheep on alfalfa seems to lie in following of a few well defined rules.

First, the alfalfa ought to be fairly well grown. It is much better if it is near the blooming stage when they are turned into it. It is all wrong to turn them in the field in early spring, letting them gnaw off the buds from the crowns as they start to grow. That is a practice bad for the alfalfa and not very helpful to the sheep.

Second, the sheep should be filled up full on green feed before being turned in to the alfalfa. If in addition they are given some dry grain, provided they are accustomed to this, all the better. They should be turned in at about 10 or 11 o'clock in the morning of a sunny day.

Third, they should have salt before them at all times. It is thought that it is better to mix with this salt air-slaked lime, about two parts of lime to one of salt. I have not tested this but it has the weight of good authority.

Finally, once introduced to alfalfa the sheep should not again be taken off of it, neither by night nor by day, nor in rain nor dew nor at any time till they are taken off for good. And when they are taken off and it is desired to introduce them again

it will take even more care the second time than it did the first to accustom them safely to alfalfa, because they will be ravenous for it.

The only exception to this rule is that it may be advisable sometimes to allow them to go to the sheds for shade in the middle of the day. If this is done care should be taken that they are returned to the alfalfa field as soon as they are willing to leave the shade in the afternoon.

Thus managed, the writer in an experience of several years lost from 2 per cent to 4 per cent of the flock from all causes during the pasturing season, partly attributable to bloat.

Varying Practice.—Regions differ as regards the bloating effect of alfalfa. In some places it seems to be impossible to pasture sheep on it at all. In other places it is an easy thing to accomplish safely.

In Arizona and New Mexico there is now a large use of alfalfa pasture for lambing ewes in springtime. The same is true in parts of California. I was told in California that along the Sacramento there was much loss from bloating, while along the San Joaquin and southward to the Imperial Valley there was little or no loss at all. Perhaps the alfalfa along the Sacramento was more nearly unmixed with grasses, or was of a more succulent nature.

In Argentina millions of sheep and lambs are fattened on alfalfa pasture, no grain being fed them. Usually there is a natural admixture of grasses.

On Woodland Farm I practiced feeding lambs on

alfalfa pasture as I would pigs, with ear corn thrown on a clean place on the ground. The results were astonishing. Lambs born in March weighed in late June 80 pounds and were sent fat to market, at long prices.

In Kentucky some of the best early lamb growers practice turning the ewes and lambs on alfalfa that has run into blue grass considerably. The result is glorious lambs that bring the top prices and ripen weeks earlier than lambs running on common pasturage.

Ewes Get Too Fat.—The practical objection to alfalfa pasturage is that it makes ewes too fat to breed well. To remedy this one ought, if he sees such condition approaching, take them away and turn them to rather poor grass for a time. I feel certain that I have lost the use of a good many ewes from barrenness through this effect, as they became fat, ready for the butcher and not ready for the ram. One remedy would naturally be to send them as they became fat to market, but this is not practicable in a pure-bred flock.

HAY FOR SHEEP FEEDING.

Ewes in winter time need little else than alfalfa hay to maintain them in splendid condition for dropping a crop of strong lambs. Thus treated they will come in with plenty of milk. There is usually little danger of their consuming too much alfalfa hay after being safe in lamb. It is well, however, to feed some other food, not so rich, in connection with the alfalfa hay.

To give a run to blue grass or other pasture, and a little of some other sort of hay, if the ewes will eat it, or to give bright corn stover in connection with good alfalfa hay, is good practice. Sometimes ewes may be better off for a trifle of grain when they are eating alfalfa hay. If they are all right, in good health and condition when winter sets in and are afterward liberally fed with alfalfa no grain will be needed, and in truth it may be a detriment.

Feeding Value of Hay.—Illustrative of the fact that alfalfa alone is a rich enough feed we present the following table from the Kansas experiment station, giving some comparative values of alfalfa and other well known feed stuffs. The figures are for the digestible matter found in the various feeds. These figures were gotten from the results of feeding experiments at that station:

	Protein.	Carbo-hydrates.	Fat.
Alfalfa hay, cut ten per cent in bloom	13.24	39.26	0.89
Alfalfa hay, cut half in bloom	11.90	40.26	0.39
Alfalfa hay, cut in full bloom	10.43	43.17	0.69
Red clover hay	6.58	35.35	1.66
Timothy hay	2.89	43.72	1.43
Prairie hay	0.61	46.90	1.97
Corn fodder	1.98	33.16	0.57
Kafir-corn fodder	3.22	48.72	1.15
Wheat bran	12.01	41.23	2.87

Study of this table shows plainly why it is that ewes well fed with alfalfa hay are well nourished. Ewes eating alfalfa hay during pregnancy have udders well filled with milk when the lambs are born. This makes the shepherd's cares light at that anxious time. Ewes suckling their lambs will milk well on alfalfa hay with a trifle of grain in addition. Lambs born in winter will, with bright alfalfa hay and a ration of cracked corn, develop rapidly and make prime lambs for the fancy "hot house" trade.

Lamb Feeding at Woodland.—The writer was perhaps the first man east of Colorado to begin fattening lambs with alfalfa as the hay ration. His earlier practice was to feed timothy hay, shredded-corn stover, oat straw and clover hay. To balance these fodders, deficient in protein, he bought wheat bran and oilmeal. The result was satisfactory, except that the cost of making baby mutton was excessive. These lambs were fed from November until April, being bought from western ranges or from farms. About the average cost during the early 90's was $6.25 per hundred pounds for the gain put on. Concentrates rich in protein grew steadily dearer and lambs cheaper, so that it seemed that

the end of his lamb feeding was near, when he turned his attention to producing an abundance of alfalfa. He found that as good lambs could be made with alfalfa hay and ear corn only as he had been making with shelled corn or ground corn and oilmeal and wheat bran. The alfalfa-fed lambs developed a little slower, but made the gain much cheaper and with a lessened death rate. For some years the cost of producing lamb mutton on alfalfa hay and ear corn averaged about $3.50 per hundred pounds. In recent years, owing to the advanced cost of corn and alfalfa hay, the cost has increased to about $4.50 or $5 per hundred, making no allowance for labor.

It is the present practice to give the lambs a longer feeding time, buying them in November, giving little but alfalfa for a month, then a trifle of corn, gradually increasing until, in March, they may get nearly as much corn as they will eat. At no times are they fed all the corn they will eat, nor more alfalfa than they will eat clean, saving that some coarser stems are allowed to be rejected. In April or early in May the lambs are sold and they have topped the markets for years, and are watched for by buyers in Buffalo.

The manure made by these lambs, fed under shelter, is returned to the land where corn is to be planted, usually an old alfalfa sod. After one crop of corn, or at most two crops, the land is sowed back to alfalfa again. This manure is very rich and by

this system of farming the productiveness of the place is steadily and rapidly growing.

Comparative Value of the Hay.—Numerous tests have been made at experiment stations of alfalfa hay compared with wild hay or timothy hay or some other roughage for sheep and lambs. In every case great superiority for alfalfa has been shown. Thus Burnett found that lambs eating alfalfa hay and shelled corn made 52 per cent greater gains than those fed corn and prairie hay. Similar results were had in Wyoming.

Feeding Operations in the West.—It is in Colorado, western Kansas and Nebraska that one sees alfalfa feeding in successful operation in a large way. There sheep and lamb feeding is an art and a science. Alfalfa is of course the cornerstone of it. On the excellence of their alfalfa depends all their chance of profit and success. In truth the aim is to feed the sheep or lambs as much alfalfa as possible, and thus economize as far as may be in grain, which is often the costly part of the ration.

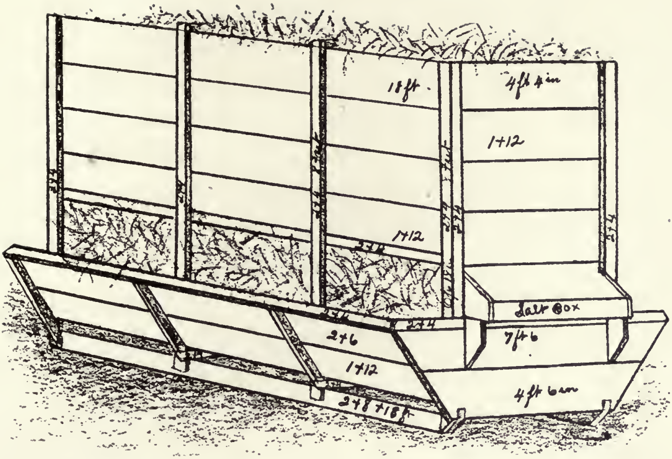
Methods in Use.—The method of feeding is admirably simple. As a rule no sheds are used in Colorado since no rain falls in winter and not much snow. Yards are erected in somewhat sheltered places and the fences so built that sheep can thrust their heads through and eat alfalfa hay which is drawn from the ricks directly to the yards and piled against the fence. From time to time it is pushed up to them as they consume it. Grain is fed in

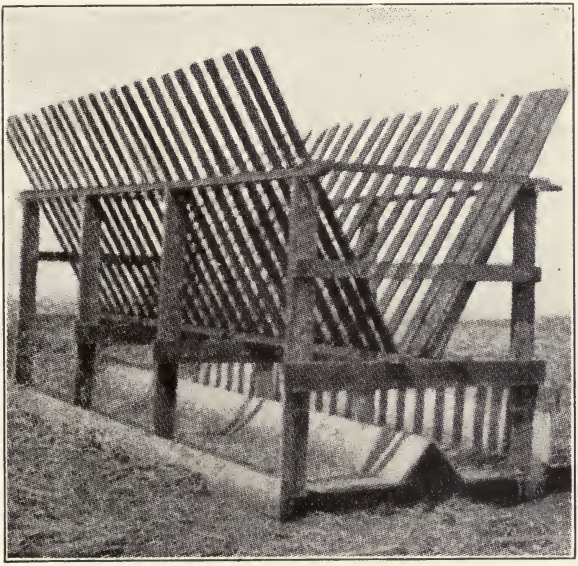
troughs. Colorado lambs usually top the Chicago and Omaha markets. The excellence of their mutton is very great. Alfalfa does it, with a proper amount of corn.

After the sheep are fed there is left a tremendous amount of manure. Once this was allowed to go to waste. Recently it has been found profitable to haul it to the fields. In western Nebraska it is often put on the old alfalfa meadows, where it has been found very beneficial.

Small Waste in Feeding.—There is no especial care necessary in feeding sheep or lambs on alfalfa hay. When hard frosts late in the season catch the alfalfa it is sometimes injurious to sheep after being made into hay. Ordinarily no harm ever comes to a sheep from having as much alfalfa as it can eat. It has been learned, however, that sheep may eat their hay up nearly clean, rejecting only the most woody portion, and thrive nearly as well as though wasting all but the finer stems and leaves. Less waste is found where the animals can thrust their heads clear into the racks, or through the fences, to reach the hay than when they must pull it through narrow cracks in the rack. The writer makes his alfalfa feeding racks with vertical slits 7″ wide. Through these sheep thrust their heads and keep them there while eating.

It is not true economy with fattening sheep or lambs to require them to eat their hay too close; better gains are had when they consume large





PORTABLE HAY-FEEDING RACKS.

amounts. There is no danger of their eating too much, as there is with mature horses. When sheep reject coarse stems they may be fed to horses getting grain with good results.

Maintaining Fertility.—Hardly any other sort of farming is so good for land as alfalfa farming, with sheep to consume the hay. Sheep make good manure. It is easily saved and applied. Wherever it is used bounteous crops are assured. In the eastern states where sheep are fed mostly under cover, the manure is especially valuable. It is said that "one can not eat his cake and have it too." This is not true of an alfalfa farm when the hay is fed to sheep or lambs and the manure put back. One has his fertility left after enjoying the profits of sheep feeding.

ALFALFA FOR SWINE.

There is rotation in farm practices as well as in crops. Take the hog for example. Originally it was a forest-dwelling animal, consuming herbage of all sorts, grasses, roots, whatever it could get, and mainly coarse herbage. Later it was taken by man and shut up in pens or yards and fed grain. Under such treatment all sorts of difficulties developed, hogs became subject to disease, lost their prolificacy, became unnatural mothers, eating their offspring. Thus the hog fell into disrepute, got a reputation for unhealthfulness and natural bad habits. Now, thanks to alfalfa, the hog is resuming its rightful place as a grazing animal, is grown largely in the fields in the winter-time, eats coarse stuff, which it ought to do, consumes alfalfa hay. The result is that in thousands of herds cholera has been banished, the hogs have become resistant because of their feed and healthful way of living, litters are larger, the sows do not eat their pigs and the cost of making pork has been reduced one-half. All this thanks to alfalfa feeding and alfalfa grazing.

The Hog a Grazing Animal.—The truth is the hog is by nature a grazing animal. While not a ruminant like the cow and sheep yet it has capacity to take care of a good deal of coarse herbage and is better for having it. There must be a certain amount of bulk in its food to distend the stomach and intestines in or-

der to keep the animal in health. If its intestines are vigorous then it may resist cholera germs, even if they are taken in. The importance of this point can not be over estimated. Millions of germs are about us, germs of all sorts. All animals take them in continually. When there is a vigorous, healthful intestinal tract these germs sometimes, even the most virulent, are either digested or passed off, the animal remaining unscathed. When there is a weak and sickly intestinal tract the germ finds lodgment and disease follows. There can hardly be any other explanation of the fact that cholera seldom troubles hogs rightly managed and kept in summer on alfalfa pasture, in winter in part on alfalfa hay.

Fine Alfalfa Pork.—This matter is so essential that I here present part of a paper read by one of the Government inspectors before the Kansas State Breeders' meeting at the Kansas agricultural college:

As these alfalfa hogs came down the alley to the scales, they were certainly hogs for the packer, raised at a profit—thrifty and ready to yield good-grade pork, for a good price was realized. You could notice that they were well up on their expanded feet; their height, length, and bones all rounded out with even fat, covered with a glossy, glistening, heavy coat of hair, and keen eyes alert. Their backs were straight, broad and well curved into long, deep sides that had plump, pointed even-shaped hams at one end and arched shoulders at the other.

On post-mortem we did not find a single parasite in livers, lungs, kidneys or intestines, as we do in hogs grown on corn and cereals. Their lungs remained expanded, that is, inflated, when cast down in the gut chute; did not collapse, and were of a perfect pink. Their stomachs were larger and did not recoil or contract readily, and same was observed of the whole intestinal tube. The man who pulled the intestines from the ruffle fat for cas-

ings said, "They are as tough as clothes-lines and as large as broomsticks." The bum-gut cutter said that "it seemed like taking out automobile tires, and I have not cut or torn a single one, they are so tough." The caul fat and ruffle fat after guts were drawn off were much heavier than the average in corresponding corn-fed hogs. The leaf-lard pullers and ham facers complained about so much fat and weight in lifting the leaf out, and it was more bound down to the inside of the abdominal walls. The splitter of backbones and sawyer of the shanks said "it was like cutting iron or railroad ties." All bones were bones, large and strong. The carcasses were symmetrically filled out like barrels, having funnel legs, and all front feet were stiff and rigid, straight out, while in other hogs the front feet are generally limp and dangling.

Their skins were well filled, shining and smooth as the human. When I read this sentence to Mr. Hodgins he laughed and said: "Don't credit it to alfalfa, for we dip our hogs every two weeks in two or three inches of crude oil and never know what lice, mange or scurf are, nor hog-cholera so far, while our neighbors on all sides of us have had it and laid it to tankage. We fed the same tankage they did, for we bought it from the same parties and at the same time." Their bodies were solid and the meat was of that marbled appearance of lean and fat, for the fat of an alfalfa hog is whiter, and here is where we get the two strips of lean in the bacon—rustling for a living makes muscle.

Alfalfa Pasture for Hogs.—No better plant has been found for hog pasture than alfalfa, nor will the hogs greatly injure the alfalfa if rightly managed. In any event, even if they do injure it, it is well to provide it, plowing it when seriously hurt and resowing. Certain points of management, however, will avoid nearly all injury.

Do Not Overstock.—The pasture ought to be larger than the hogs need. The number of hogs that a pasture will carry varies greatly, according to the size of the pigs and the quality of the pasture. It may be said that an acre will carry nicely about 1,200 to 1,600 pounds of swine, accord-

ing to its condition and the way the hogs are managed. That would mean 8 pigs weighing 150 pounds or fewer of larger animals. Not that these pigs would consume all the alfalfa in the field; it is not desired that they should. It will be mown two or three times and the surplus made into hay. This keeps the alfalfa vigorous and gives a good deal of hay. It also helps the hogs by giving them a fresh bite as it comes up again.

It is not well to mow off an entire pasture at one time as it leaves nothing for the hogs to eat for some days.

It will not do to put in enough hogs to eat a pasture down close as it destroys the alfalfa after a time, and one can never get a maximum return from land treated in that way. Alfalfa must have a chance to grow, and if it is kept nibbled down close all the time it cannot possibly grow. Thus instead of getting the most out of a pasture by stocking heavily one gets the least out of it. This is a very common error made by beginners in alfalfa growing. Make your alfalfa pastures wide and mow them regularly. Thus treated the animals get the most possible out of them and the pastures themselves will live for a long time.

Wait for Warm Weather.—Do not turn hogs in alfalfa pastures until warm weather comes. The brutal disregard for the young, tender plants displayed by some would-be alfalfa growers is most exasperating. Perhaps it comes from their habit of turning

hogs on old blue grass pastures in winter or early spring. Alfalfa is in no sense like blue grass. Keep the hogs carefully shut out of it until it is at least a foot high in spring.

Do not leave the hogs in pasture late in the fall, either, especially if you live east of the Missouri River. To pasture alfalfa late in the fall in all the eastern country will very greatly damage it if not destroy it. And never, on any account, let the hogs step foot on it in winter time.

Alfalfa not a Balanced Food.—Again, much disappointment comes from use of alfalfa in the wrong way. Hogs will not make much gain on alfalfa pasture alone. They will gain about one-half a pound a day or less with only alfalfa and water. With a little corn every day in addition to the alfalfa hay they will gain two pounds or even two and one-half pounds daily. Nearly all the corn "sticks to the ribs" when hogs are fed on alfalfa pasture.

It is unreasonable to expect hogs to fatten on alfalfa pasture alone, or even to expect them to make all their growth on alfalfa pasture. Alfalfa is exceedingly rich in protein, but is deficient in fat and carbohydrates. Why can not the hogs make up on grass what the alfalfa lacks? Well, because a hog has too small a stomach, is not a ruminant, does not chew its cud. It wants a part of its ration in some condensed form. The alfalfa gives health and vigor and makes growth, but it needs the aid of corn. There is no other grain so good for feeding with

alfalfa. They are happily wedded together, corn and alfalfa.

Grain Needed.—It is as unwise to feed either corn or alfalfa alone to hogs as it would be to send to a mason bricks alone or mortar alone. He cannot build a wall without bricks and mortar in right proportions. So the hog cannot build without corn and alfalfa in right amounts. One can trust him to eat the alfalfa, feeding it freely; there will not be too much consumed. He can not let the hog choose how much corn he will eat because he will eat too much for greatest profit. The corn should be limited, the alfalfa unlimited. Thus come cheapest gains and most profit.

Amount of Grain.—How much grain when on alfalfa? The Nebraska experiment station has reached this conclusion:

A light grain ration is not the most economical for growing pigs, unless under peculiar circumstances, when alfalfa is abundant, grain very high in price, and market conditions warrant holding the hogs. It seems probable that two or more pounds of corn daily for each hundred weight of hogs is more profitable than a lighter ration.

Mature hogs, thin in flesh, may be expected to gain about half a pound per head daily on alfalfa without grain. Mature hogs, fed corn in a dry lot while being fattened, required nearly one-half more grain to produce 100 pounds gain, and gave a daily profit of 3 cents less per hog than similar hogs running on alfalfa pasture. Alfalfa may be fed with profit to growing or fattening hogs in almost any form so long as it does not make up too large a proportion of the ration. When cut (chopped or chaffed) and fed as one-quarter of the ration with ground corn it materially reduced the cost of gains and increased the profits.

Value of Alfalfa Pasture.—Certainly this varies according to the productiveness of the pasture, the

management and the price of hogs. It may reach anywhere between $10 and $35 per acre. The Kansas experiment station realized $24.10 from an acre of alfalfa pasture.

In 1907 C. E. Quinn, a special agent of the Department of Agriculture, investigated the pasturing of alfalfa with hogs in the west, giving especial attention to conditions in Kansas and Oklahoma. The report is found in full in Farmers' Bulletin 331. It is so pertinent here that we quote freely:

During the past summer (1907) about 150 of the most successful swine growers and pork producers of Kansas and Oklahoma were interviewed on the subject of the crops used for feed. In Southern Oklahoma along the river valleys and in northern Oklahoma and southern Kansas the farmers are favored with a soil and climate that makes it possible to produce pork very cheaply. The mildness of the climate makes it unnecessary to build as expensive shelters for hogs in winter as are required farther north, and the short open winters make it possible to furnish pasture during a greater portion of the year, thus lessening the amount of grain which it is necessary to feed. The main pasture crops for hogs in this region are alfalfa, wheat, oats, and rye, ranking in importance in the order named.

It is the testimony of 95 per cent of the farmers interviewed in this region that there is no better forage crop for hogs than alfalfa, where it can be grown successfully.

Amount of pasturage.—As to the amount of pasturage or the number of hogs alfalfa will carry per acre without injury to the crop, the estimates given by farmers very considerably, depending on the kind of soil, the fertility of the land, and the size of the hogs pastured. The following, however, is a safe average estimate as given by conservative men who have had much experience. River valley and creek bottom land well set in alfalfa will carry from 15 to 20 head per acre of 50 to 125 pound hogs. Upland of fair average fertility will support from 8 to 10 head of the same kind of hogs. There are fields that have supported 25 head per acre all through the season for a number of years and are still in good condition, and there are other fields that will not furnish pasture for more than 5 head per acre; but these are extremes.

When a field is used only for pasture it is better to divide it into several lots and move the hogs from one to the other as occasion requires.

Causes of Failure.—Those who have failed with it as pasture owe their failure to two causes: The first is that the alfalfa has been pastured before it has become well rooted. Young alfalfa is too tender a plant to stand severe treatment except under very favorable circumstances. There are a few farmers who have pastured it the same year it was sown and the alfalfa has survived; but this was on rich heavy loam soil, usually creek bottom or river valley land with water not far below the surface, and the season was very favorable. Ordinarily alfalfa should not be pastured until the second year, and better still not until the third year if it is desired to keep the field as permanent pasture.

The second cause of failure with alfalfa is heavy pasturing and lack of judgment in pasturing in unfavorable seasons. A good many farmers have sown a small piece of alfalfa, and then, because it has grown rapidly and all kinds of stock are fond of it, they have turned all the stock on the farm on it and have wondered why their alfalfa was killed out. Others pasture regardless of whether the ground is muddy or whether the season is dry and hot. In either case heavy pasturing is very likely to cause the alfalfa to be killed out.

Length of Pasture Season.—The length of the season during which this pasture is furnished also varies. Alfalfa is ready for pasture on the average from the middle of April in southern Oklahoma to the middle of May in northern Kansas. It is not best to pasture earlier, as the young alfalfa has not the start it should have for heavy pasturing, nor has it the substance in the plant. When not pastured too early, it will furnish feed at the rate mentioned during nearly the whole season until October in the northern part and November in the southern part of the section referred to. In some years the pasture season will continue a month later in the autumn, owing to the rainfall and the lateness of cool weather. In some seasons, if the summer is unusually dry and hot, the pasture will become short; but usually pasture for the number of hogs mentioned can be depended on for about seven months of the year at the southern limit of the territory named and for about five months at the northern limit. This rule will apply to other sections of the country having the same climatic conditions as Oklahoma and Kansas.

While many farmers pasture alfalfa fields to their full capacity, in some sections, especially in northern Kansas, it is customary to run about half as many hogs as the alfalfa fields will support.

This practice permits the cutting of the usual number of crops of hay, though the yield of hay is of course reduced.

Food Character of Alfalfa.—Alfalfa not only furnishes a great amount of pasture, but it is of a character that goes to make bone and muscle. It belongs to the leguminous family of plants, as do the clovers, the cowpea, the field pea, the soybean, and the vetches, and, while it is furnishing this valuable food, it is adding fertility to the land. Either alfalfa pasture or alfalfa hay, with corn, forms very nearly a balanced ration for animals; and, while it is better to have a grain ration fed with it to hogs as well as other animals, a healthier, thriftier hog can be raised on alfalfa alone than on corn alone. Many instances are found where hogs have been raised on alfalfa alone. One Oklahoma farmer marketed in December, 1905, 61 head of spring pigs eight months old that averaged 171 pounds, which had run from the time they were little pigs with their mothers on 15 acres of alfalfa without any grain. They sold on the market for 5¼ cents a pound. This made the cash value of the alfalfa pasture about $38.35 per acre. As will be seen, this is a light pasturing, as there were only about 4 pigs per acre besides the brood sows.

Feeding Practices and Actual Results.—As already stated, it is much better economy to furnish a grain ration with the pasture, as it results in better gains and better product. One man estimates that it takes from one-half to one-third less corn on alfalfa pasture than on a straight grain ration to make a hog ready for market. Many let the hogs run on alfalfa until about six months old, by which time they reach a weight of 75 to 125 pounds, feeding just a little grain; then they feed heavily for about two months and sell the hogs at eight months old weighing 200 to 225 pounds. One farmer, who raises about a thousand hogs a year and who in one year sold $11,200 worth of hogs, makes a practice of raising his hogs on alfalfa pasture until about eight months old, feeding one ear of corn per head daily. He then feeds heavily on corn for a month or two and sells at an average weight of 200 to 225 pounds. Another man feeds all the corn and slop the pigs will clean up, all the while running them on alfalfa pasture, and sells at six to eight months old at weights of 250 to 300 pounds. Another, who raises about 1,000 head a year, feeds all the corn the pigs will eat, beginning shortly after weaning and continuing until the hogs are sold at ten to eleven months old, averaging about 275 pounds.

Still another farmer, from weaning time (two months old) until eight months old, feeds the pigs nothing but dry corn on alfalfa pasture, averaging about one-half gallon of corn (3½

pounds) a day per head. At the end of eight months he sells at an average weight of 250 pounds. The quantity of corn fed is about 11¼ bushels per head. Figuring at the average price of corn in this locality, 35 cents, and the price received for pork, 5¼ cents, the following results show the cost of growing pork on this farm and the value of alfalfa pasture:

Value of 250-pound hog, at 5½ cents	$13.75
Value of pig at weaning, 50 pounds, at 5½ cents	2.75
Gain from pasture and grain	$11.00
Cost of 11¼ bushels of corn, at 35 cents	3.93
Value of pasture per head pastured	7.07

Now, compare these results with those of a man who had to depend on other pasture crops than alfalfa. He estimates that it will take 15 bushels of corn on wheat, oats, and rye pasture to raise and fatten a hog so it will weigh 240 pounds at nine months old, besides the pasture and slop. At the price of corn mentioned, 35 cents a bushel, and with hogs at 5½ cents a pound, note the cost of producing pork on this farm:

Value of 240-pound hog, at 5½ cents,	$13.20
Value of pig at weaning, 50 pounds, at 5½ cents	2.75
Gain from pasture and grain	$10.45
Cost of 15 bushels of corn, at 35 cents	5 25
Value of pasture per head pastured	5.20

The pasture on this farm will not support more than half as many head per acre as alfalfa. Its value is only $5.20 per head, against $7.07 per head for alfalfa pasture on the other farm.

The experiences of these men are sufficient to show the value of alfalfa pasture alone, its greater value when grain is fed in connection, and that it is an important factor in economic pork production.

Alfalfa Hay.—While alfalfa pasture has been found to be very valuable for hogs, the hay as a part ration for winter is scarcely less important. Throughout the region referred to the farmers are feeding the hay to hogs in winter. The hay has been found to be especially valuable for brood sows before farrowing. Where it is fed during the winter only a small ration of grain is necessary to keep the sows in good flesh and in healthy condition. Sows thus fed also farrow good litters of strong, healthy pigs.

Feeding Methods.—Many feed the hay by throwing it on the ground in forkfuls; others have made low racks in which the hay is placed, where the hogs can feed like cattle or sheep. The hay is usually fed dry. The leaves are more readily eaten by the hogs than the stems, and they contain more of the nutri-

tive value of the plant. For these reason some farmers save the last cutting of hay for the hogs because it is more relished. It is eaten up cleaner, as the stems are not so woody. Sometimes the hay is cut up fine, wet, and mixed with other feed, and sometimes it is fed ground, as there are now alfalfa mills scattered throughout the alfalfa regions. But it is very doubtful whether this extra expense will pay, unless it be for a ration for young pigs.

Experiences of Farmers.—To avoid the expense of cutting or grinding, some farmers in order to get the hay all eaten have soaked it in water and fed it. This has proved very satisfactory where tried. One Oklahoma farmer carried his hogs through a winter by feeding them alfalfa leaves soaked in hot water for one day and the next day shorts mixed with the pulp and water. He feeds much alfalfa hay to his hogs and is very successful with them. He puts the last cutting in shock as soon as wilted, and thus cures it without bleaching and feeds it to his hogs. Another farmer carried his entire herd of hogs through the winter by feeding them the pulp of alfalfa hay after soaking it in water over night. He also gave them the water to drink. This was all the feed they had during the winter, and they were in good flesh in the spring, with smooth, glossy coats of hair. A Kansas farmer was feeding a bunch of 50 fall pigs on corn. During the winter they got "off feed" and were not thrifty. He reduced the corn and gave a ration of two-thirds chopped alfalfa hay and one-third corn meal, the two soaked together. The hogs began to do better, and a little later he changed the ration to one-third alfalfa and two-thirds corn. The results were very satisfactory, and the cost of feed was reduced from $15 a month on corn to $9 a month on alfalfa and corn. So alfalfa hay, as well as pasture, has a very important use on a hog farm.

Alfalfa Hay for Brood Sows.—To show the importance of alfalfa hay in a system of feeding, the practice of the farmers around North Platte, Neb., and elsewhere may be mentioned. The alfalfa hay is ground up fine or else fed whole with corn in the proportion of about 5 pounds of alfalfa to 1 pound of corn. This is fed to the brood sows during the winter, and they come through in excellent condition on very cheap feed. In many sections alfalfa hay is worth about $5 a ton on the farm. One ton of alfalfa and about eight bushels of corn will keep three brood sows 130 days, or nearly the whole winter. The hogs so kept farrow pigs that are remarkable for their vigor and size.

Views of the Nebraska Station.—Prof. H. R.

Smith, of the Nebraska station thus approves the use of alfalfa with hogs:

I cannot recommend too strongly the feeding of good alfalfa hay to any kind of swine. It not only furnishes protein, or flesh-making material, which is deficient in corn, but it tends to offset the heavy character of a ration consisting of corn alone. Some scatter the hay on the ground, but it is better to construct some sort of a rack through which the hogs can pull the hay without trampling too much under foot. If the feeder has a cutting machine it might be well to cut the alfalfa and mix it with the grain. For fattening purposes do not make this cut alfalfa more than one-fourth of the entire grain ration by weight, and I would be inclined to believe that one-fifth alfalfa would be better.

At the Nebraska station also Burnett fed alfalfa leaves in comparison with wheat middlings to growing pigs. The pigs having the alfalfa leaves made the better gain. In Illinois A. J. Lovejoy cuts alfalfa very fine, almost as fine as meal, and mixes it with corn meal, wetting all and feeding to pigs with first-rate results. Instances might be multiplied almost infinitely, but one more must suffice. Ex-Gov. W. D. Hoard, of Wisconsin, a man who has done very much to introduce alfalfa culture into eastern America, carries his brood sows through the winter with alfalfa hay and skimmilk from his dairy. The sows come through in splendid condition, with no unnatural or depraved appetites, farrow splendid pigs and have much milk for them.

The Pork Industry Prominent.—The hog occupies indeed a commanding position in American agriculture. The value of the hog in America in January, 1909, was near $356,000,000. To grow these hogs costs American farmers, the writer estimates,

$300,000,000. With alfalfa to help cheapen the production at least $100,000,000 may be saved.

This is not nearly all the story, either. Hog farming is not usually a type of farming adapted to soil-building or even conserving of fertility. Hog farming usually means a farm devoted to corn and a few small muddy yards where all the corn is dumped to be devoured by the imprisoned swine. Thus in these small yards accumulates all the fertility of the farm. The net result is weeds, jimpson weed, dog fennel, all sorts of vile things, while the fields grow steadily poorer and poorer as there is nothing to go back from the hog feeding. Now with the use of alfalfa and feeding much of the corn in the alfalfa fields the land is renewed, its fertility increased, it carries more stock and becomes more easily tilled. The difference between alfalfa farming with hogs and hog farming without alfalfa is that where alfalfa is lacking the land is steadily destroyed, where it is had it is steadily built.

ALFALFA FOR POULTRY.

All sorts of fowls love alfalfa, green or dry. In truth they love it not wisely but too well for the alfalfa when it is a young thing, and unless kept away from it will destroy it. After it has become established they will not usually injure it unless the alfalfa is a small patch near the poultry runs. It is well to keep them away from the field when the alfalfa is coming up as they will peck the seedlings and destroy every one at a bite.

Giving the Run of the Field.—Poultry having a run to an alfalfa field will need very little additional feed. Indeed on Woodland Farm it is the custom to grow a hundred, sometimes two or three hundred guineas that simply live half wild in the alfalfa fields. They subsist entirely on alfalfa leaves, insects and what they find wild. They nest as they like and of course a great many of the eggs are lost, since they lay sometimes a hundred in the one nest and the mower often smashes many of them.

Poultry having alfalfa lays exceedingly well. In winter time all fowls love the alfalfa leaves and will even eat the smaller stems. If the alfalfa is cut very fine they will eat nearly all of it. Certainly only the best alfalfa hay should be offered the fowls. In any barn where alfalfa is fed there can be secured bags of alfalfa leaves and fine stems that the fowls

will eat with great satisfaction. Some poultry keepers advise wetting the leaves, or pouring boiling water over them, which makes them freshen up amazingly; others think as good results come from feeding them dry.

Meal and Cut Hay.—Alfalfa meal is admirable for poultry and egg production. Where alfalfa is not grown and the hay is therefore unavailable doubtless the meal is a profitable source of vegetable food and protein. It stimulates egg production and is thought to have some influence in making the eggs fertile.

For home use, where alfalfa hay is available it is well to cut the hay in very short lengths, the shorter the better probably, choosing very early cut, tender and well cured hay for this purpose. This will doubtless do nearly or quite as well as alfalfa meal, and the leaves from the feeding barn will do best of all since they are most digestible of any part of the alfafa plant.

It is noticeable that when alfalfa is available in winter egg production is greatly stimulated.

MAKING ALFALFA MEAL.

Within recent years a considerable business has sprung up in the West of making alfalfa meal. Several plans are adopted for making this meal. The hay must first be carefully selected. Only well cured bright green hay is available. With some processes this must afterward be kiln-dried before it is put in the mill. It is then ground to a fine powder. Another machine makes meal of the dry hay without kiln drying. This meal is not so fine a powder as the first mentioned. A third type simply cuts the alfalfa exceedingly fine with a modification of an ordinary hay-cutter. This is the most rapid in operation of any machine and the resultant product seems to be as digestible as any. It is not exactly meal, however, and is often sold baled, a lock of alfalfa hay being placed at each end of the bale. This seems the most practicable way of handling it for dairy feed. The fine ground meal, however, may sell more readily in the market, though it is doubtful if it is any better as a feed.

Meal and Bran.—Prof. H. M. Cotterell says that in one test where alfalfa meal was fed in comparison with wheat bran, giving the same weights, the alfalfa meal made 141 lbs. of milk, the wheat bran 100 lbs. The Pennsylvania experiment station on the other hand reported that alfalfa meal gave no better results than wheat bran, yet with alfalfa meal

and wheat bran rated at equal costs the meal made slightly the cheaper milk.

Difference in samples might readily account for this difference. Much meal is doubtless made of very coarse, woody hay, cut when over ripe. This would naturally make less milk than meal from early cut hay. I believe alfalfa meal to be a good product, but do not think it ought to be rated above wheat bran in feeding value or selling price.

Easy of Transportation.—Probably the chief good of alfalfa meal is to carry alfalfa to towns and cities and regions where alfalfa is not grown. There remains to be discovered evidence that it would pay the farmer to grind his own alfalfa into meal for use on his own farm, unless it might possibly be for pig feeding in winter time, and even there the evidence is in favor of using the alfalfa in its natural form or cut very fine.

Alfalmo is a product of alfalfa meal and molasses. One who has observed the very great use of molasses feeds in England must conclude that there is a field for them in America, and that this alfalmo, if honestly made, as it seems now to be, has a future before it as a fattening ration for cattle and horses, perhaps for pigs as part of the ration. Should we be able to introduce alfalfa meal into England there would be opened a wide field and a great market. Perhaps we will need all our alfalfa hay at home for some years; perhaps such a market would in the long run rebound to our injury.

PLOWING ALFALFA SOD.

A well set alfalfa sod is a hard thing to plow. It takes power and time to break it. And yet, for a given amount of energy applied in plowing one will get much greater returns in an alfalfa sod than he will with any other sort of plowing, so he need not feel aggrieved at the resistance of the alfalfa roots.

The longer the alfalfa has stood the larger and tougher the roots are. Alfalfa only a year or two old plows not much unlike red clover sod. It is the old field that gives one a tussle. To attempt to plow that with a dull plow, a poor team and broken harness is to waste one's energy.

The Right Way.—On the other hand, rightly gone at alfalfa sod is a delight to plow. One needs a good team, three heavy horses, a first-class plow (preferably a walking plow, not a sulky or riding plow, which rarely is successful in alfalfa sod). He wants two good shares and then to keep one of them in the blacksmith's shop most of the time, being sharpened; a sober, intelligent man holding the plow, with a file in his boot leg, then plowing alfalfa sod is as easy a job as one would care for, only it is rather slow work. We plow in the fall usually or early winter. The field that is to be plowed is mowed late. It is as well to save that last growth, and it will weaken the roots somewhat to

have it cut off. We plow alfalfa sod deep. Why? Because the roots cut off easier down eight inches or more. It is true that they will grow again, that is, the upper part will grow, and your field in the spring may look almost as though it had not been plowed. Do not let that fact trouble you. When cultivation begins the alfalfa will soon disappear. This is assuming that the field is to go to corn or potatoes or some other cultivated crop. If sown to oats it is likely that the alfalfa would grow up in them pretty thick and maybe trouble in the harvest. But oats lodge in an alfalfa sod anyway, so they do not count.

One finds that the soil itself is loose and easily made friable after alfalfa has grown upon it, so he can plow it deeper than ever he did before and find soil all the way down.

Setting the Plow.—Now about setting the plow. We use a rolling coulter and a pair of wheels on the beam. One can buy trucks to fit a walking plow, or he can have wheels adapted to the use by his blacksmith. It is probably cheaper to buy the trucks. As we needed them on Woodland Farm before any manufacturer had started making them we made our own. The wheels hold the beam steady, exactly at the right depth. It is an old device that has been in use for centuries in Europe, but has not been imitated in America simply because we have run after cheapness too much, and because we have not done much good plowing as yet. With these wheel trucks a small boy can plow alfalfa sod almost as well as a

man. A boy will do better plowing with a good plow nicely adjusted with these wheels on the beam than any man could do without the wheels.

The File Important.—The file is one of the essentials. On Woodland Farm where there are some small stones in the land we file the plows sharp after they have run about ½ mile or a little more. It takes only a few minutes to do this and no longer to file often than it would to file occasionally, and by filing often the plow is always sharp. The horses are resting while you file.

Early Start Desirable.—It is rather slow work plowing alfalfa sod at best. Therefore it is well to get at it early in the season. After growth starts in spring alfalfa roots get very tough, and if the land is dry and hard at the same time the plowing is difficult.

To sum up, get a strong plow, preferably with a good stiff wooden beam. Put truck wheels on the beam, well forward, to hold it true. Have the share wide and sharp. If the roots are old and tough have a wing fastened on that will run under the edge of the next furrow and cut off the roots there for about three inches. Keep the plow sharp. Take time. We have not found it necessary or advisable to plow twice; one good plowing at a depth of about eight inches has done the work well for us and would do the work anywhere probably wherever the land was cultivated the following season.

Breaking Sod in Colorado.—Prof. Philo K. Blinn

of the Colorado experiment station gives his experience thus in "The Rural New Yorker":

The attempt to break alfalfa with the ordinary plow is usually a miserable failure, as it is not suited to the work. A very successful alfalfa plow can be made by adjusting and making a few changes in the regular sod plow or prairie breaker. The essential points to consider are: The long strong beam to steady the plow; the long landside to resist the tremendous cutting strain. It is often necessary to reinforce the beam with heavy iron to withstand the draft. The plow should be adjusted to cut a very narrow furrow, not over 12 inches; an extra long share to lap part of the last furrow to prevent the roots near the heel from whipping around, only partly cut off. This can also be prevented by a horizontal cutter bolted to the bottom of the landside, thus partly cutting the roots in the next furrow; this cutter is forged with a right-angle shoulder that fits and fastens with the bolt through the short landslide.

The next essential is a very sharp share, drawn thin and hardened so that it will not be brittle. A sharp share should be replaced each day and a good file is necessary to touch up the edge once in a while. Breaking alfalfa on stony land is very difficult, and is extremely hard on plow shares. The most essential point in an alfalfa breaker is a long, heavy, well-pointed share with a very wide wing six or eight inches at the heel, and 1½ to two inches of the edge rolled so as to run almost flat on the bottom of the furrow, thus cutting ahead of the lift and avoiding a dragging cut. The standard plow factories are making for the western farmer alfalfa specials with extra alfalfa shares; these are chiefly in sulky plows, but where it is not practical to afford such a plow the walking breaker can be fitted and adjusted to do excellent work, though it is somewhat harder for the man that holds the plow. Alfalfa breaking usually requires three to four good heavy horses for a team.

The depth and time to plow alfalfa are somewhat mooted questions. They vary with conditions. It is usually conceded that fall breaking is a success, but in Colorado, alfalfa is generally plowed shallow, four to five inches deep, so that the roots and crowns may be well harrowed to the surface to dry out. It is then replowed one or two inches deeper than it was broken. Alfalfa when dormant, if plowed under in moist soil, will readily take root and grow if not harrowed out. Many farmers are having better success in breaking alfalfa late in the spring, after the alfalfa is 10 or 12 inches high, plowing under the green manure.

The growth seems to have exhausted the stored plant food, and if the roots are all cut very little will start to grow, especially if the field is planted to some crop like potatoes, that can be well cultivated. Complaints about difficulties in plowing alfalfa usually come from sections where rotation with alfalfa has not been started long.

ANIMAL PESTS AND DISEASES.

The pocket gopher is a serious pest in the alfalfa field. In many western states it is indeed a most serious menace. In all the non-irrigated parts of California the gopher cuts short the life of an alfalfa field. Irrigation stops their work, but irrigation is not always possible. T. J. Headlee of the Kansas experiment station thus discusses the gopher and his work in Bulletin 155:

No other animal attacking the underground parts of alfalfa can equal or even closely approach the gopher in destructiveness. While the pocket gopher occurs in all parts of the state it is most abundant and destructive in the valleys of the Kansas River and its main tributaries. The plains pocket gopher (*Geomys lutescens*, Merr.) holds sway on the western plains, and the prairie pocket gopher (*Geomys bursarius*, Shaw) infests most of the remainder of the state. These two species show such a similarity in life-habits that for the consideration of methods of combating a knowledge of the prairie form will serve for both.

The prairie pocket gopher is short and stocky, showing an average length of about ten inches from the tip of its nose to the end of its stubby, hairless tail. Its body is covered with silky dark brown hair, its eyes are small and well protected by fur, and its ears are so short as hardly to cause a ripple in the smooth-lying fur of the head. Its front feet are furnished with long, strong claws and otherwise modified for digging. In fact, the whole structure of the animal fits it for its subterranean existence.

The gopher tunnels hither and thither in search of food, at intervals digging short lateral burrows to the surface through which it pushes the excavated earth and dumps it outside, thus forming the mounds that indicate its presence and mark its progress. These animals are most active during the fall and spring, and one individual may throw up several mounds daily for several weeks at a time. During these seasons the work of a few gophers in an alfalfa-field may cause the uninitiated to suppose

the field infested by dozens. Although the animals are most active at these times they work only less vigorously throughout the rest of the year. Even in winter, whenever the ground is sufficiently free from frost, they throw up mounds here and there.

Except for possible brief excursions at the periods of mating and migrating, the gopher passes practically its entire life in its burrow. Indeed, it is a rare occurrence to find one abroad on any errand. They appear to live solitary, each individual gopher apparently bent on having his world to himself, and each digging and taking care of his own dwelling. Doubtless where fields are so badly infested that tunnels cross and recross, more than one gopher may be trapped in the same runway. The female produces but one litter of young per year, yet because of her sheltered life raises enough of them that the species is constantly increasing.

The natural food of the gopher consists of succulent roots and such green vegetation as can be dragged from the surface into the burrow. The coming of alfalfa, with its deep-growing succulent roots has largely solved the question of food supply for this animal by providing it with an abundance easily accessible both in winter and summer. Truly the conditions of the alfalfa field are such as to render life easy for the gopher tribe.

Not only does the animal injure alfalfa by actual consumption of the roots, but by covering up a considerable portion (sometimes 20 per cent) of the area badly infested, and by rendering the crop in fields so infested difficult to harvest.

Many methods of combating these animals have been tested at this station, and poisoning has been found at once the quickest and most efficient. Shooting and trapping require too much time, and fumigation is inefficient. Pieces of potato, apple, and sweet potato, about the size of the end of the little finger, poisoned by inserting a few crystals of strychnine into slits made with the point of a knife, or raisins and prunes treated in the same way, and carefully introduced into fresh runways, have given excellent results. While these baits are as successful as any used, much time is required in their preparation, and the station has therefore undertaken the manufacture and sale (at cost of materials and labor) of a poisoned syrup, one quart of which is sufficient to poison one-half bushel of corn. The corn is put to soak in hot water the evening of the day before the bait is to be used. In the morning the water is drained off, the requisite amount of poison poured over the corn and thoroughly mixed with it. Cornmeal may be used to take up the excess

moisture, and the bait is ready for use. Any citizen of the state is entitled to a copy of the formula according to which this syrup is manufactured and may make it for himself if he so desires. The station sells the prepared poison for $1.10 per quart, delivered to the express or freight agent at Manhattan.

Whatever sort of bait may be used, success depends upon introducing it into fresh runways. Choose fresh-looking mounds and prod on the line between them with a wagon rod or sharpened broom handle to locate the runway; or, failing there, prod about the freshest mounds. The sudden giving of the soil and the apparent looseness of the stick in it is sufficient to show that the runway has been located. Remove the prod and drop a teaspoonful of the poisoned bait into the burrow, leaving the hole open. Level the mounds with some sort of a drag, and as fast as new ones appear locate the burrows and put poison into them.

In case the area to be treated is large some sort of a special instrument for locating the runways is desirable. A very good one can be made from a spade handle by covering the pointed end with iron and fastening a foot-rest about fifteen inches above the point.

By the use of the means just described the enterprising farmer can rid his land of gophers and keep them out of it. Once the farm is freed, the vigilance and prompt treatment necessary to keep it so will require but little time and effort.

No other creatures now attack the underground parts of alfalfa with sufficient vigor to demand attention, althought moles and spermophiles, particularly the latter, may become injurious later.

Grasshoppers.—Several species of grasshoppers feed on alfalfa and do it at times notable injury. Fall disking is recommended to destroy the egg masses of the hoppers and this will perhaps be pretty efficient so far as it goes, though no doubt millions of eggs may be deposited along the margin of the fields and along roadsides. For the hoppers that come in spite of this disking the hopper-dozer is recommended. Essentially a dozer consists of a shallow, high-backed pan mounted on runners high enough so that its bottom will scrape the tops of the alfalfa

stems. The dozer is filled with water and coated with a film of kerosene. It is used in the warm part of the day because then the hoppers are decidedly most active.

When it is drawn forward through the infested field, the hoppers spring to get out of its way and most of them may land in the water and be destroyed by contact with the kerosene. If enough turkeys and guineas are kept hoppers will be much reduced in numbers.

Ants.—Webworms, army worms, fall army worms, cutworms and blister beetles all occasionally injure alfalfa more or less. Mound-building ants are troublesome in western fields. The ants are readily destroyed by use of bisulphide of carbon. Taking note that the ants are canny and carefully guard their homes, Prof. Headlee thus comments:

On the approach of a storm a large force is employed and the gateways are closed in haste, but when it has passed they are reopened and the ants return to their work.

The ant colonies are too few to decrease the yield seriously, although occasionally they will destroy the alfalfa on from one to two per cent of the total area of a badly infested field. Their claim to rank as alfalfa pests lies principally in the increased difficulty of harvesting the crop when they are present.

Extended experiments have shown that the ants can most easily and efficiently be controlled by fumigating the nest with carbon bisulphide as follows: Set fumigation only when gateways are open; invert a galvanized iron vessel, such a common washtub, over one or more of the openings, covering as much of the mound as possible; firmly pack soil over such holes as the tub will not reach; introduce under the tub and near the holes a shallow dish containing from one to three ounces (depending on the size of the nest) of carbon bisulphide; set the tub down and quickly pack soil about the rim, making it as nearly air-tight as possible; allow to stand for five hours. The forming vapor, being

heavier than air, sinks downward and comes to fill every chamber and gallery, destroying all the occupants.

It must be remembered that carbon bisulphide is as explosive as gasoline and must be used with equal care.

Conclusions.—The conclusions of Prof. Headlee as to the proper way to combat these insect enemies of alfalfa are as follows:

When we call to mind that the grasshopper passes the winter in the soil in the egg stage, the web worm, army worm and cutworms remain in the soil over winter as larvae, the fall armyworm as a pupa, that the blister-beetles are dependent upon a supply of grasshopper eggs for food during one necessary stage, it is plain that thoroughly stirring the soil with a disk-harrow (preferably the spike-tooth kind) just after the frost is out of the ground and before the plants begin to grow, or, better still, in the late fall just before the ground freezes, if such a proceeding would not injure the plants, will go far toward controlling the insects enumerated. During the summer, when these insects are in the field or when the alfalfa is attacked by clover hay worms, leaf-hoppers, mound-building prairie ants or pocket gophers, the grower must resort to measures especially fitted to destroy the enemy in question.

To this I would add that in the eastern states insect enemies are much less in evidence in alfalfa fields, owing probably to the cold, wet winters, and the pocket gopher has not yet been introduced, though he is probably on his way. Woodchucks or groundhogs are a pest in eastern meadows; they are readily destroyed by use of bisulphide of carbon. The way to use it is to saturate a rag with a tablespoonful or more, throw it down the burrow as far as you can and immediately stop the hole tight. A sod may be laid over it first, then earth heaped on it. All holes should be treated as they may communicate with each other.

Prairie dogs are readily suffocated with the same chemical, or they may be poisoned in early spring, before growth starts, or they may be drowned out if irrigation water is available.

For the neighbors' chickens no adequate remedy has been discovered.

GROWING ALFALFA SEED.

Alfalfa does not seed well as a general rule in any moist climate. Hardly any alfalfa seed is threshed east of the Missouri River. A little is harvested in Ontario and occasionally a man has saved and threshed seed in Illinois, Indiana, Ohio or New York. Stray plants in almost any location, standing out by themselves, especially if on a bank or some dry situation, will usually set full of seed. A field adjacent might be left for seed and make hardly any at all. Why this is we do not understand.

It will seldom pay the eastern farmer to attempt to grow alfalfa seed. He can buy it cheaper than he can grow it. Even in Kansas, Nebraska and other western alfalfa seed-producing states the seed crop fails if the season happens to be wet.

Adaptability of Seed.—Alfalfa seed is valuable for different sections according to its source. Thus seed from Nebraska or Kansas thrives in Ohio, Indiana and New York. Seed from Arizona is not hardy in Nebraska. Seed from Montana will not produce so well in Texas as seed from Arizona. Alfalfa is like corn, it adapts itself to climates. The rule of survival of the fittest comes in play also, so it is most wise to take account of the place where your seed was grown. Seed imported may thrive in one part of the United States and fail to thrive

well in another part. Seed from Peru will winter-kill in one place and thrive exceedingly in another. Arabian seed gives a good account of itself in one part, is a failure in another. As with corn, it is safer to take seed from north of you rather than from south of you.

A Money-Making Crop.—Fortunes may be made in growing alfalfa seed. Millions of acres that are too dry for profitable grain-growing will grow alfalfa seed under right treatment. The demand is insistent and rapidly increasing. The supply is not often equal to the demand. In 1890 I bought alfalfa seed for $4 per bushel of 60 lbs. It is now worth $10 to $12. It is very desirable that alfalfa seed should be cheaper. It is a plant that would come into short rotations if only the seed were cheap enough. There is profit in growing it at half the present prices.

A Kansas View.—The following study of alfalfa seed growing is by Prof. A. M. TenEyck of the Kansas agricultural college:

The Soil.—Good crops of alfalfa seed may be produced on a variety of soils, ranging from black gumbo to sandy loam, but the general experience is that the soil should be well drained and of average fertility. Very fertile land, and soil supplied with an abundance of moisture, produces plant, not seed. On this account in central and eastern Kansas upland or second bottom is usually considered superior to bottom-land for alfalfa seed production. A soil poor in fertility will produce only light crops of seed, while large yields of seed may be produced from fertile land in a favorable season, but with unfavorable weather conditions the seed crop is more apt to fail on the more fertile soil. Rankness in growth of plant is not conducive to the production of seed. Alfalfa will not thrive on a shallow soil with hard-pan subsoil, or on low or poorly drained land.

The Weather.—In the opinion of many alfalfa growers the weather is a more important factor than the soil in determining the production of a good crop of alfalfa seed. On a given soil capable of growing alfalfa, the weather is the determining factor in seed production, or it may be as truly said that the moisture supply, in time and amount, largely determines the alfalfa seed crop on any field. On this point a majority agree that the alfalfa should have a moderate supply of water in the early part of the season, and during the early growth of the seed crop—just sufficient moisture to produce a vigorous, healthy plant. To insure a good crop of seed no heavy rains should fall after the alfalfa begins to blossom until most of the bloom has fallen, and then the weather should continue rather dry until the seed crop is harvested and threshed, or put into the stack. Wet weather in the latter stage of its growth causes a continuation of blooming and the starting of a second growth of alfalfa, which interferes with an even and proper maturing of the seed. Also it has been observed that the hot, dry weather, with a deficiency of moisture in the soil during the seed-forming period, has resulted in light, blasted seed and a low yield. It is said that under the conditions observed alfalfa flowers fail to secrete nectar and are hence not fertilized because not visited by bees and other insects.

Other Factors.—A rather thin stand of alfalfa with vigorous plants of average growth favors the development of seed, while a thick stand and a rank growth of plant are considered unfavorable conditions for seed production. The seed fields should be comparatively free from weeds. By cultivating the alfalfa early in the spring, or perhaps after the first or second hay crop is removed, the weeds may be held in check and the soil kept in good tilth, resulting in strong, well developed plants, capable of producing large yields of sound, plump seed.

Effect of Bees and Other Insect.—Until recently it was generally understood that to fertilize alfalfa blossoms required that pollen from a separate flower be brought in contact with the pistil of another flower. This, it was explained, was doubtless largely accomplished by insects, which transferred the pollen from blossom to blossom while they sipped the nectar which each flower secretes apparently for this very purpose of attracting insects. It is probable that cross-fertilization is largely accomplished in this way, but, as shown by Roberts and Freeman of this station, alfalfa blossoms may be self-fertilized. It is only necessary that the "trigger mechanism" which controls the fertilizing organs be sprung by the touch of an insect or other means, possibly the shaking of the plant in a strong wind, when

the confined stamens and pistil fly up and the pollen is dusted against the stigma and over the insect, or, in case of hand pollination, the instrument which is used to spring the little flower trap. Thus the insect, passing from blossom to blossom, mixes the pollen of many flowers, but the hand pollination has shown that the blossom may be fertilized with its own pollen.

Farmers are divided upon this point as to whether insects are necessary or useful in the pollinization of the flowers. Many maintain that as good crops of seeds were produced many years ago, before bees were introduced into a certain locality, as are produced now. Others state that in a locality where bees are kept there is no noticeable difference in seed yields near apiaries compared to yields from fields further away. Such data, however, do not disprove the facts as stated above. Doubtless other insects besides bees assist in fertilizing the alfalfa flowers. If you will observe an alfalfa field in full bloom you will usually find it swarming with insects of various kinds—bees, flies, butterflies, millers, ants, and sometimes grasshoppers—although it is doubtful whether the latter are of any benefit, and certain it is that they are often a pest when numerous. It is quite possible that ants are among the important insects concerned in fertilizing alfalfa blossoms. There is some proof that bees do assist in pollinating the alfalfa flowers.

Although reports on this point have not been very authentic, there seems to be little question but that bees may assist in fertilizing the alfalfa blossoms and thus increase the yield and improve the quality of the seed. At this station alfalfa plants covered with fine netting produced no seed except in flowers which pushed through or against the netting, allowing fertilization by insects from the outside. On the other hand, adjacent plants not covered were well filled with seed pods.

There should be a double benefit to the alfalfa seed grower who keeps bees, for not only may he secure larger yields of a superior quality of seed by reason of the work of the bees, but the alfalfa is one of the most valuable honey plants. In the alfalfa districts of the state the yield of honey per hive, according to the report of Secretary Coburn of the State Board of Agriculture, is much larger than in the sections where alfalfa is but little grown; and not only may the bees in alfalfa districts make double or treble the usual amount of honey, but this honey is very superior in quality, unequaled even by the white clover honey of the eastern states. "In favorable seasons, 100 pounds of honey per hive is no uncommon yield in alfalfa regions."

Which Crop to Save.—The region lying west of the Missouri

River grows most of the alfalfa seed produced in the United States. A large part of this seed is grown by irrigation in the western part of the great plains region, in several of the mountain states, and in California. Much seed is also produced without irrigation in the eastern part of the great plains region. The dry climatic conditions of the West make this section of the country better adapted for the production of alfalfa seed than the more humid regions of the central and eastern states. The best quality of seed and the largest crops are produced in an arid climate by irrigation. The supply of water and the weather conditions during the growing period of the crop largely determine which crop to save for seed. Any one of a season's crops may produce good seed provided the soil and weather conditions are right for growing and maturing seed. About the same time is required to produce a crop of seed as is required to produce two crops of hay. In the irrigated districts of Colorado and western Kansas the first crop is often saved for seed, the practice being not to irrigate this crop, thus causing a medium but thrifty growth of plant, which, with the favorable weather conditions prevailing in the arid regions, usually seeds well.

On the whole, especially in the more humid regions, the second or third crop is more often saved for seed than the first crop, mainly because more favorable weather conditions prevail in the late summer and early fall for maturing the seed. Also, the insects which may help to fertilize the blossoms are more numerous in the latter part of the season. Only in the southern states is it possible to use a later crop than the third for seed.

In those latitudes where the third crop may mature seed before cool weather and frost, the choice between the second and third crop for seed is decided mainly by the weather conditions at and before the blossoming period. If the supply of moisture has been moderate and the alfalfa has made a proper growth and little or no rain falls during the blossoming period, the second crop will likely seed well. However, if the second crop is rank in growth, or heavy rain falls just previous to or when the alfalfa is in bloom, it is best to cut for hay. In the non-irrigated area of the semi-arid portions of Kansas and other western states drought is apt to prevail in the latter part of the season, by which the growth of the third crop is greatly reduced, causing only a small development of seed. In such districts the second crop should be saved for seed, or perhaps the first crop, especially on dry uplands which may produce only one good crop (the first crop) in a season. In northwestern Kansas and Nebraska it is doubtless safer to use the second crop for seed, as the third crop is apt to

be caught immature by frost. In central-northern Kansas a farmer must usually decide whether to save the second or third crop; if the third crop is to be saved for seed it is best to cut the first and second crops a little early, giving as much time as possible for the third crop to mature. Also the early cutting for hay may give not only an earlier but a more vigorous growth to the third crop, insuring a large production of seed in favorable seasons.

Some growers state that the third crop should be preferred for seed because it blooms and matures more evenly and in a shorter period than the second crop. If this is a fact, it may be largely due to the favorable weather conditions which are more apt to prevail during the season of the year when the third crop is growing and maturing. When it can be successfully done, using the third crop for seed has an advantage over using the second crop in that it allows the harvest of two good hay crops, while if the second crop is harvested for seed only one crop of hay is usually secured that season, the growth after the seed crop being insufficient, as a rule, in the sections of Kansas named, to produce hay.

On the other hand, when the third crop is matured for seed sufficient growth of the alfalfa usually takes places after removing the crop to give a good winter cover, and it is the general report by those who practice this plan that, taking the third cutting for seed does not exhaust the alfalfa plants so much as taking the second crop for seed, and a similar observation is made as regards the seeding of the first or second crop, some growers reporting that when the first crop was allowed to mature seed there was little or no growth after the seed crop was removed, during the balance of the season.

Insect pests, as the grasshopper and web-worm, are also a factor in determining whether the second crop, or any crop, may be safely saved for seed. The web-worm is more likely to attack the second crop, but in southern Kansas the third crop is also apt to be injured by this pest.

A Good Seed Crop.—Alfalfa is a very uncertain seed crop, and it is a difficult matter to estimate with any degree of accuracy early in the growth of the crop what the yield of seed will be. If the weather and soil conditions have been favorable and the alfalfa has made a proper growth (not too thick and rank, but rather the stems should be of medium height and stout, with many branches), and there is an even, heavy bloom over the field in five or six days after the first bloom appears, and no rain falls, the prospect for seed is good. The blooms should be large and of a dark, rich color. When the blossoms are small and light in

color it is evidence of a light crop of seed. Again, if the blossoms fertilize properly the flowers dry and stick to the stem a few days, while if they are not fertilized they drop quickly and the stems stand bare. Even before the bloom falls the circular pods are visible. The pods should appear thickly set on the stems, two or more in a group, to insure a good seed crop. Finally, if by examination the pods are found to be well filled with seed, the crop is assured, barring accidents by which the seed may be lost in harvesting and thrashing.

From the above suggestions it may seem to the novice that he would be able to judge fairly well when a crop of alfalfa should be left for seed; yet old growers do not find it easy to decide. A grower who has had twenty years' experience writes as follows: "I cannot tell when a good crop will be made until near maturity, as the blossoms often fail to seed, and then too much rain may cause well-fruited alfalfa to take a second growth and continue to bloom and ripen seed irregularly. Also during damp rainy weather the ripe seed may sprout, or when the weather turns dry the ripe pods may burst, shattering their seed." It is even possible that after a crop is ready to harvest it may be lost or badly damaged by excessive rain, causing the seed to sprout or the pods to burst when they dry in the sun.

Relative to saving a crop of alfalfa for seed these suggestions may be given: If the weather has been wet and the alfalfa grows too rank, cut for hay. If heavy rains fall while the alfalfa is in bloom, or before the flowers are fertilized, cut for hay. If for any reason the flowers are not fertilized and the bloom falls quickly, leaving bare stems, cut at once for hay. Even after the seed is formed, if excessive rains come and a second growth starts, cut the crop and remove it, because it will fail to ripen seed evenly and is almost certain to be an unprofitable crop, and the sooner it can be taken from the ground the sooner another crop may start and mature.

When to Harvest for Seed.—The harvesting depends a little upon the evenness of blooming and the weather conditions during the period of maturing. In a favorable season, with even blooming and even maturing of the seed, the rule is to harvest the alfalfa when a large proportion of the pods have turned brown. In the average season, as the alfalfa matures, part of the seed will be ripe while some of the seed is overripe and shattering and some is yet immature. With such a crop it is necessary to strike an average and harvest when the largest amount of plump, sound seed may be saved.

The opinions of farmers vary widely regarding the proper

stage of maturity at which to harvest alfalfa. While the majority prefer to harvest when most of the seed is ripe and when two-thirds to three-fourths of the pods are brown, others recommend to harvest when one-half of the pods are brown. One grower harvests the crop when one-third of the pods are black. One grower harvests the crop when one-third of the pods are black, one-third brown, and one-third green; others harvest as soon as the ripest seed begins to shatter, while still others maintain that the first seed that ripens is the best and prefer to cut a little early, claiming that the seed will be of as good quality and that there is less loss from shattering in handling and less danger of damage by unfavorable weather.

Mature alfalfa seed has a clear, light-golden color; immature seed has more of a greenish tinge and may be shrunken; but if the crop is not harvested until the seed is fully ripe the pods drop off, the seed shells easily, and the crop is hard to handle without great loss, even if it escapes unfavorable weather after harvest. On the whole, it seems to the writer safest to cut the crop a little green rather than to risk loss in ways mentioned. The greenish-colored seed, if not too shrunken, is good vital seed and germinates well.

Methods of Harvesting.—A crude method is to cut with a mower and rake into windrows the same as hay. Handled in this way much seed may be wasted. If the alfalfa is mowed in the morning, when the dew is on, and raked immediately, there is much less shattering of seed. If cut during the heat of the day, to prevent the shelling and waste of seed men should follow the machine with forks, moving the cut alfalfa out of the way of the team and the machine. When provided with a buncher or windrower attachment, the mower does better work and may be economically used. There is some objection to leaving the alfalfa in loose bunches or in open windrows, and unless the weather is very favorable and the purpose is to thrash at once, it is best to follow the mower closely, placing the alfalfa in larger piles or cocks, about what a man may lift at one forkful, thus avoiding pulling the bunches apart in loading, which would cause the pods to break off and the seed to shatter. Also if the alfalfa is placed at once in the cock in this way, the seed is prevented from bleaching so much and the straw settles and sheds rain and is preserved and cured better than when left in the loose bunch or windrow, and well-cured alfalfa straw is said to have one-half the feeding value of alfalfa hay.

The self-rake reaper is in common use, and is an excellent machine with which to harvest the alfalfa-seed crop. The gavels are

dropped from the platform out of the way of the horses and the machine. Usually men follow with forks and lay three or four gavels in a pile. These bunches shed rain and preserve the seed and straw in better condition than the single gavels, and the seed does not shatter so badly in handling the larger compact bunches as in handling the smaller ones.

Some few growers cut the crop with a header, leaving the alfalfa in windrows across the field. This method is only satisfactory in a dry season, when the alfalfa is thrashed or stacked at once, as soon after harvest as possible.

Many western growers harvest alfalfa with a binder. The usual practice has been to remove the binder part, but leave the packers on and throw the bundles out loose, dropping in bunches by use of the bundle-carrier, or bunching with the fork as already described in the use of the self-rake reaper. In recent years, however, some prefer to bind the alfalfa in bundles and shock the same as wheat or other grain. The advantage claimed for this method is that it requires less help, since one man may do the harvesting and put the crop into the shock if help is scarce; the alfalfa may be cut a little greener, the seed does not shatter so readily, and the straw may cure and keep better than when put up loose.

When bound and shocked the alfalfa should stand a couple of weeks, until dry enough to thrash. If put into the stack, thrashermen prefer to have it loose, as bundles are more apt to be damp and tough, but if fully dried when stacked alfalfa should keep well in the bundle. It is suggested to stack with layers of straw between layers of alfalfa, in order to take up the moisture.

Stacking and Thrashing.—The common practice, when it can be done, is to thrash from the field as soon after harvest as the seed is dry and the straw fully cured. If a machine cannot be secured and weather conditions are favorable for stacking, better put into the stack at once when the crop is cured than to run the risk of damage by wet weather. A single rain will not injure the alfalfa much if it is well bunched or cocked, but continued wet weather causes the seeds to swell and perhaps sprout, and when the pods dry they burst, scattering the seed. Some growers estimate that half of the seed is lost in this way by a few days of unfavorable weather. Also, if the crop is allowed to lie in the field for a long time there is more or less loss of seed from the effects of heavy dew and damage from mice and insects, and the longer the alfalfa lies the easier the pods break off and the seed shatters when it is finally handled and stacked or thrashed. The largest amount

and best quality of seed may be secured by stacking or thrashing the crop as soon after cutting as it is in fit condition.

Care should be taken not to stack or thrash when the straw is too green or tough and the seed not fully dry. It requires even more time to cure properly the seed crop of alfalfa than it does to cure the hay crop; the stems are largely stripped of leaves and cure slowly and pack closely in the stack. If stacked green, the alfalfa is sure to heat and thus injure or destroy the vitality of the seed. Also if thrashed green or damp much seed will be lost, since it will not hull properly, and if damp seed is stored in bulk it may heat and spoil. To cure the alfalfa fit to stack, from three to seven days of favorable weather are required, and a longer period if it is thrashed from the field. When bound and shocked the crop should have a couple of weeks of drying weather to cure before stacking or thrashing. It is safest to put into narrow stacks, and it is also a good plan to mix with layers of dry straw, especially if the alfalfa is bound and there is any indication that the straw is damp or green in the middle of the bundles. The straw improves the ventilation of the stack and absorbs the excessive moisture. The practice of using straw in this way, however, is seldom practicable—better stack only when fully cured.

To prevent loss of seed in stacking or thrashing, racks are sometimes covered with canvas and canvas is spread under the machine or along the stack in order to catch the shattered seed and the bolls which break off; also care must be taken to handle the alfalfa carefully in pitching and loading. Large growers of alfalfa often stack the seed crop in the field with the sweep-rake and hay-stacker. Those who practice this method usually cut with the mower and leave in bunches or windrows, drying the alfalfa quickly and stacking as soon as possible. This is a rough way to handle the crop and occasions more or less loss of the seed, but where a large area is handled it may be more profitable to handle the crop in this way than by a slower method and run the risk of damage from wet weather. When the alfalfa is left in gavels or bundles, as thrown off by the harvester, it should be taken up with a barley fork. There will be less shattering of seed, however, if the alfalfa is in small compact bunches, not too heavy to be lifted in one forkful.

When the alfalfa is stacked, unless thrashed within two or three days after stacking, it should be allowed to pass through the sweat before being thrashed, which requires several weeks or months. The best plan is to cover the stacks well to prevent damage by rain, and thrash late in the fall when the weather is dry and cool. In order to secure seed for fall sowing it is often desir-

able to thrash from the field, and in a favorable climate or season, if a machine can be secured, this is the safest and most economical method of handling the crop.

Farmers differ in their opinions as to whether it is preferable to thrash with a huller or with a common grain separator provided with a huller attachment. Some growers favor the use of the latter machine because the work can be done more rapidly. As a rule, however, when farmers have had a chance to use both kinds of machines, and have compared their work, the huller is preferred. Although it takes longer to thrash with a good huller, yet with a good crop enough more seed may be secured to amply pay for the extra time and expense required; in fact, the owner of a huller will often pay something for the privilege of thrashing over again the straw-stacks left by the common thrasher. Among the machines used, the Birdsell huller is well recommended; also the Advance thrashing separator with huller attachment has received favorable mention. One farmer who has used both machines prefers the Advance thrasher to the huller.

Storing and Marketing the Seed.—A good method is to sack the seed and store in a dry place which may be kept free from mice and rats. It is stated by some growers, however, that mice and rats will not touch alfalfa seed when they have free access to other grain.

The seed should be cleaned with a good fanning-mill before selling, and all light seed, dirt and weed seed removed as far as possible. This extra work is usually well paid for in the better price received for clean seed. If the alfalfa is green or damp when thrashed, the seed had best be spread twelve or eighteen inches deep on a tight floor in a dry place and shoveled over once or twice to dry before it is cleaned and sacked. Prime alfalfa seed should have a bright, clear, light-golden or slightly greenish color. Seed which has been wet or bleached in the field will be darker in color, while heated seed will have a brownish dead color, indicating its lack of vitality.

From the grower's standpoint, the best time to sell the seed is when the price is highest. Prime seed usually sells at a high price early in the fall, when there is apt to be a shortage of seed for fall sowing, and again early in the spring, about March 1, seed often brings the highest price, depending largely upon the supply and demand. Alfalfa seed retains its vitality for several years if carefully stored and saved, and it may often be to the interest of the grower, when seed is plentiful and the price low, to hold the seed for a better market.

Aside from its use for sowing, alfalfa seed has a standard mar-

ket value in Europe for dyeing purposes, being used in the printing of cotton fabrics, and large quantities of seed have been exported from this country to supply the foreign demand. For different years and in different parts of the country the price has ranged from seven to fifteen cents per pound. A bushel of alfalfa seed weighs sixty pounds. Three to four bushels of good seed per acre is a profitable crop. The average crop in the more favored alfalfa regions ranges from five to seven bushels per acre, while yields as high as twelve bushels per acre have been reported. A yield of less than two bushels per acre is an unprofitable crop.

Importance of Good Seed.—An immense amount of failure with alfalfa comes through getting bad seed. There are various causes of bad seed. Sometimes it is grown in the wrong latitude and thus fails. Some alfalfa seed is grown in Algeria and is exported through France. It is improbable that this Algerian seed would succeed in Ohio or Illinois or Nebraska. Thus in imported seed it is hard to tell what one will get. Some French seed is very superior and well adapted to eastern America.

Adulterations.—The worst of seed, however, is that containing the weeds and adulterations one often gets. For instance, one day recently I visited a newly established alfalfa field situated in a region where alfalfa is a new plant, struggling to get recognition. To my astonishment the young growth proved to be nearly every bit burr clover. Burr clover seed is always cheaper than alfalfa seed, and the enterprising seedsman had adulterated his alfalfa seed so vigorously that there was only a remnant of alfalfa left. I have seen fields so nearly a pure stand of yellow trefoil that the stray alfalfa plants looked like weeds.

Examine Samples.—It is safe to get samples of alfalfa seed before buying and submit them to your experiment station for examination, or to the Department of Agriculture at Washington, choosing the seedsman according to the quality of his seeds. There are many honest seedsmen, but perhaps few competent or sufficiently careful seedsmen.

Edgar Brown of the Bureau of Plant Industry Department of Agriculture, has made careful study of imported and home-grown alfalfa seeds and thus presents the case in Farmers' Bulletin 194:

Alfalfa seed is about the size of the seed of red clover, but is easily distinguished from it by its uniform light olive-green color, as contrasted with the purple and yellow of clover seed. Unlike red clover, it varies considerably in shape.

Adulteration.—Alfalfa seed is often adulterated; numerous samples have recently been received at the seed laboratory for examination which contain a considerable percentage of yellow trefoil seed. A few samples have also been received which contain burr clover.

Yellow Trefoil.—The seed which is most used in this country as an adulterant of alfalfa is yellow trefoil. It is darker green than alfalfa, so that a sample containing from 10 to 40 per cent of it looks brighter and better at the first glance than slightly discolored alfalfa seed. Yellow trefoil seed, however, can be easily distinguished by an expert, on examination, through a small lens, by the differences in shape. Figure 2 shows the typical form of yellow trefoil seed.

Yellow trefoil is a low-spreading, leguminous plant grown for sheep pasture on some of the poor, light soils of Europe where other forage crops do not grow. It is not grown to any extent in the United States and is of no value where clover or alfalfa is successful.

Importation of Yellow Trefoil Seed.—On account of the low price of yellow trefoil seed and its resemblance to alfalfa and red clover it is imported into this country in considerable quantities and used as an adulterant of both these seeds. During the six months from June 30 to December 31, 1903, 110,760 pounds of yel-

low trefoil were imported and practically all was used to adulterate alfalfa and red clover seed.

Chilean Lucern.—Under the name of Chilean lucern, or luzerne, burr clover is used as an adulterant of alfalfa seed in Germany and has recently been found in seed offered for sale in the United States. It is obtained from the woolen factories in Germany which use Chilean wool. Burr clover grows abundantly in Chile, and the burrs catch in the wool as the sheep are pasturing. In the process of combing the wool the burrs are removed, and the seed is afterwards cleaned and put on the market to be used as an adulterant of alfalfa seed.

This seed is similar to that of alfalfa in shape, and though slightly larger and lighter in color, it lends itself most readily to use an an adulterant. There are two species occurring in about equal quantities, which are apparently the ones common on the Pacific coast of the United States (*Medicago arabica* and *Medicago denticulata*).

Color of Dead Seed.—A mixture of dead seed can easily be detected by the color. Fresh seed which will grow is light olive-green and when rubbed in the hands gives a bright, glossy surface. Whenever alfalfa seed is any shade of brown it will not grow and is worthless. If a sample contains any considerable percentage of discolored seed it should not be accepted.

Weed Seeds.—The best grades of alfalfa seed contain comparatively few weed seeds. The low grades, however, which are mostly screenings, often carry large numbers of weed seeds. Dodder is the weed most destructive to the alfalfa plant. It is a parasite having no leaves and appears as a tangled mass of fine yellow stems winding about and clinging to other plants. The seed germinates in the ground and sends up a slender stem that winds around the alfalfa plant to which it attaches itself. The dodder root soon dies, while the stems continue to grow and thrive on the juices of the alfalfa until it has matured seed or the alfalfa has been killed.

Dodder occurs over most of the area where alfalfa is grown, except in the extreme northern states. When once established it is very destructive and difficult to get rid of. The only effectual way to combat it is to mow the infested area and burn the cutting. There are two species which are about equally common and destructive to alfalfa and red clover. The seeds of these are of nearly the same size and are not easily distinguished. The larger dodder seeds approach the smaller alfalfa seeds in size and therefore are difficult to clean out thoroughly. In buying alfalfa seed it is essential to know that it is free from dodder.

Cost of High-Grade and Low-Grade Seed.—It is usually safe to assume that the highest grade and consequently the highest-priced seed offered by any one firm is the cheapest to buy. In the high grades of alfalfa the seed that will grow costs less per pound than that in the low grades. When samples from different firms are to be compared a careful estimate of the quality of each should be made and the best quality selected. A good grade of alfalfa should contain not over 2 per cent of impurities, and from 90 to 95 per cent of the seed should grow.

Home Testing.—It is difficult for one who is not accustomed to handling alfalfa seed to determine accurately its percentage of purity, especially the amount of dodder and other weed seeds present, but a general estimate of the quality of unadulterated seed can be formed on a basis of color. The percentage of seed that will grow can easily be determined by means of a simple tester.

Mix the seed thoroughly and count out 100 or 200 seeds just as they come, making no selection. Put them between a fold of cotton flannel or some similar cloth, taking care not to let the seeds touch one another. Lay the cloth on a plate, moisten it well, but do not saturate it, cover with another plate and keep at a temperature of about 70° F. Every day count and take out the sprouted seeds. In from four to six days all of the good seeds will have sprouted, and the percentage of seed that will grow is known.

Free Tests.—The seed laboratory of the United States Department of Agriculture is prepared without charge to make tests of alfalfa seed and of other seeds, both for germination and for mechanical purity. The test for mechanical purity consists in determining the percentage of pure seed and of weed seeds, including dodder. All samples sent for testing should be addressed to the Seed Laboratory, U. S. Department of Agriculture, Washington, D. C., and should be accompanied as far as possible by the following information: Name and address of seller, year and place of growth, price paid, and name and address of sender.

Summary.—The average quality of alfalfa seed on the market is frequently low.

A considerable quantity of adulterated and dead seed is being offered for sale.

Do not buy alfalfa seed that is adulterated or that is brown in color.

Do not buy alfalfa seed containing the seeds of dodder.

Get samples and test them, or have them tested, in all cases before buying.

Seed Growing in the Semi-Arid West.—Within recent years there has been a remarkable migration of people from the older states to the semi-arid regions of the West. They have gone there under the belief that the climate has changed and that from now on there will be enough rainfall for crop-growing with the usual grains and farm crops. Many hope to do these things by the practice of dry farming methods, of intensive culture and moisture conservation.

I am most unwilling to dampen any man's enthusiasm or lessen his faith in his chosen habitat, yet I can not help but remember that I have seen the same thing attempted at least once before, and the climate then did not stay changed, but perversely became dry again, aridity resuming its ancient sway. Yet I remember in my own desert home, in a region too dry to attempt any farming at all except irrigation farming, stray alfalfa plants grew and bloomed and made great wealth of seed. In fact I had a scattered row of alfalfa plants 30 miles long beside the trail to the ranch, where a sack borne on a burro's back had leaked a tiny stream as the animal jogged its slow way across the desert trail. Only here and there a plant grew and survived, but those that got rooted lived along, year after year, bloomed and made seed. I often thought then, near 30 years ago, that the desert could do one thing well, if nothing more: it could grow alfalfa seed.

Every bit of the semi-arid West, from the limit of

profitable corn production to the edge of the sage brush, and even beyond this a little way, can with right management produce alfalfa seed. And this alfalfa seed growing may pay as well as good grain crops will pay in more rainy lands. I am fortunate in having at command a careful study of this whole subject by two master minds, Charles J. Brand and J. M. Westgate, of the Bureau of Plant Industry, Department of Agriculture, which is submitted:

The growing of alfalfa in cultivated rows for seed is of more recent origin in this country than is the production of hay by this method. John Spurrier, in a book entitled "The Practical Farmer," published at Wilmington, Del., in 1793, appears to be the first American writer to mention the growing of alfalfa in cultivated rows. The cultivation was designed to retard the development of weeds, which often prove very destructive to the broadcasted seedings of alfalfa in the Middle and South Atlantic States. This method is still practiced to a slight extent in a few places in the South, where, however, the climate is too humid for the successful production of alfalfa seed.

In England as early as 1730, Jethro Tull, the inventor of the drill and the originator of tillage of farm crops in the modern sense, advocated and practiced the growing of alfalfa (lucern) in rows. His teachings first appeared in his "Specimens." Later, in 1829, these were republished by Cobbett in a work entitled "Tull's Horse-Hoeing Husbandry."

What was apparently the first attempt to grow alfalfa for seed in cultivated rows in this country was made by what was then known as the Section of Seed and Plant Introduction of the United States Department of Agriculture. Several contract fields of Turkestan alfalfa were seeded in wide rows in different parts of the Great Plains area in 1903. The poor seeding habits of Turkestan alfalfa when grown in this country, together with the fact that the plants were grown much too thickly in the rows, greatly handicapped the logical development of this method.

The application of the row method of cultivation has been suggested by a number of American experimenters, including Prof. W. J. Spillman, Prof. W. M. Hays, Prof. W. A. Wheeler, Mr. W. M. Jardine and Mr. C. S. Scofield. Of these only Prof.

Wheeler has used the method on an experimental and field scale and his results are confirmatory to those presented in this paper.

The work on which the conclusions here presented are based has been conducted at various experiment farms of this bureau and on the farms of Lewis Brott, Sextorp, Neb.; E. Bartholomew, Stockton, and Dr. W. A. Workman, Ashland, Kan.

Row cultivation for seed growing has been in use for a number of years in the vineyard regions of southern Germany, particularly in Baden and Bavaria, in the production of seed of Alt-Deutsche Fränkische luzerne, a well-recognized German strain. It is said that alfalfa is grown in cultivated rows for seed in parts of Russia, where hand cultivators prove an effective and practical means of holding the weeds in check and of conserving soil moisture.

The method has been employed for a number of years by Dr. L. Trabut, government botanist of Algeria. Fairchild describes a method of growing wheat between alfalfa rows in Algeria under light rainfall, where it has been found possible to produce a crop of wheat between the wide rows of alfalfa in alternate years. The practical value of this method for the semi-arid portions of the United States was indicated in the publication mentioned, without, however, making any direct reference to the seed-producing possibilities of alfalfa sown in cultivated rows under such conditions.

Principles of Seed Production.—Although alfalfa has been grown increasingly in the West since 1854 or 1855 little has been done to develop a rational seed industry. It is a matter of common observation that even in recognized seed-producing sections the seed crop is very uncertain. A study of some of the factors that cause success or failure has indicated some of the underlying principles affecting the production of profitable seed crops. In Bulletin 118 of this bureau attention was directed to the fact that cultivated alfalfa is not a homogeneous species, but is composed of numerous races, strains, varieties, and even sub-species. These vary greatly in many characters, and especially in their seed-producing capacity, no pure varieties of known high value comparable with those we have of corn, wheat, and other crops having as yet been established. It has also been noted that the individuals constituting these diverse races, elementary species, or whatever they may be called, exhibit great variation among themselves. This is particularly true of their ability to set seed. To overcome the source of error resulting from this diversity in individual plants the method of vegetative propagation described by Westgate and Oliver, of the Bureau of Plant Industry, has been used in a portion of this work.

It has often been noted that as a rule isolated alfalfa plants set seed far more profusely than those in all but the thinnest stands. Observations on this point have been made in various parts of the Great Plains and intermountain areas and in the farther Southwest. On the Arlington Experimental Farm, near Washington, D. C., an experiment was performed to determine the effect of different degrees of isolation on the seed-setting ability of alfalfa. In this experiment, cuttings from a heavy-seeding plant were rooted in the greenhouse and later set out at varying intervals. Inasmuch as these plants were propagated vegetatively from the same mother plant, they did not show the individual variation mentioned above that would have entered into the experiment had seedling plants been utilized.

The plants occupying a space equivalent to a 7-inch square produced a maximum of 38 pods, while those having at their command a space equal to an 11-inch square produced a maximum of 96 pods. The highest number of pods formed on plants grown in rows 39 inches apart and 18 inches apart in the rows was 505.

It will be noted that the yields were in almost direct proportion to the areas occupied. However, it was evident that the plants having the greatest distance between them had not utilized fully their allotted space. This was accounted for by the fact that it was their first season's growth. An adjoining two-year-old cutting from another plant of similar seed-producing tendencies produced 2,080 pods, and this without utilizing all of the space of 18 inches in the 39-inch row assigned to it. Although part of this difference may have been due to inherent capacity, the chief explanation for it must be sought in the firm establishment of the plant and its greater maturity.

Just why the isolation of plants increases the production of seed has not been fully determined, but it is apparent that one of the factors involved is the increased amount of sunlight available to the plant. It has often been observed that trees grown on the banks of irrigation ditches in alfalfa fields or along the margins of fields always interfere with normal seed production as far as the influence of their shade extends. In the course of an experiment on the seed setting of alfalfa it was found that partial shading materially reduced the quantity of seed produced by plants not already receiving more than the optimum amount of sunlight.

When alfalfa plants have sufficient space for full development they have approximately equal illumination on all sides. With the plants so far apart that when fully developed they barely occupy the ground the potential seed-producing surface exposed on an acre is nearly double that of a thick stand. In the latter,

because of crowding, the plants are unable to produce seed, apparently on account of shading by closely associated individuals.

In addition to the injurious influence of shade, the crowding of plants interferes with seed production by depriving the plants of sufficient moisture to enable them to mature their seed properly. This, of course, is true only in areas of light rainfall. On the other hand, in sections where irrigation is practiced thick stands by checking evaporation bring about such moist conditions in fields as to promote unfavorable conditions and so prevent maximum yields of seed.

The basal shoots which usually appear when the plant begins to bloom are developed at the expense of the seed crop. The energy that should be devoted solely to the maturing of the seed is diverted by this new growth. Perhaps the most important factor influencing the development of these basal shoots which are to form the succeeding crop is the water content of the soil. If the moisture supply be ample, the basal shoots commence their growth about the time the plant comes into bloom. This is disastrous to the seed crop, and for this reason it is necessary that there be a sufficient shortage of moisture at this time to retard or prevent altogether the development of these shoots. In the seed-producing sections of the more humid parts of the Great Plains area profitable crops of alfalfa seed are usually obtained only in the occasional seasons of drought so extreme that the yield of other crops is greatly reduced.

Drought is used here in a qualified sense. There must of course be enough moisture in the soil to enable the seed to mature fully; otherwise it will be deficient in germinating power. On the other hand, the soil must not contain enough moisture to force into growth the crown buds that produce the succeeding crop.

The favorable conditions for the production of alfalfa seed which prevail in the semi-arid regions are due principally to the presence there of a favorable adjustment of the supply of moisture in the soil to the moisture requirements of the plant when grown for seed. This is especially true when the plants are grown in cultivated rows, as the moisture content of the soil can then be regulated to some degree by proper cultivation.

Insects and the Setting of Seed.—Insect visits are essential to the proper pollination of the alfalfa flower. If fertile seed is to be produced in any quantity it is necessary that a certain explosive mechanism within the flower be released. The release of this mechanism, whether it be accomplished by insects or otherwise, is popularly called tripping.

Experiments and observations both by the writers and by other

investigators indicate that practically no seed is produced if the flowers are not tripped. Bumblebees (*Bombus* spp.) are generally believed to be the most efficient of all insects in setting off the explosive mechanism, and hence in bringing about pollination. Honeybees, though not nearly so effective as bumblebees, should not be underrated in this connection. It is a practice in some parts of the country to place beehives along the margins of alfalfa fields intended for seed. Beekeepers follow with their colonies fields planted for seed, for the purpose of getting the honey. This is mutually beneficial, as larger yields of both seed and honey result. Wild bees (*Andrena* spp. and *Megachile* spp.) and various butterflies are also valuable agents in pollinating alfalfa flowers.

That the explosion of alfalfa flowers may be accomplished by other means than insect visitation is quite well known. The insertion of a more or less pointed instrument into the throat of the corolla has often been resorted to in studying the tripping mechanism of individual flowers. Roberts and Freeman describe a method of exploding flowers in large numbers by rolling the head carefully but firmly between the thumb and the first and second fingers. This trips the flowers then at the proper stage of maturity. Tripping on a still more wholesale scale may be done by grasping the entire plant between the hands at successive intervals. In this case it is best to work from the bottom toward the top of the plant, exerting the required pressure at the proper intervals.

It has been found that flowers tripped by any form of manipulation set seed readily, while other flowers left unexploded and from which insects are excluded rarely set seed.

As only a slight pressure on the keel is necessary to trip the flower artificial methods may be resorted to as a means of supplementing the natural process as accomplished by insects. In an experiment at the Arlington experimental farm in which the method mentioned of exerting pressure successively over the whole plant was used, the yield of pods was increased 25½ per cent over adjoining rows not thus treated. At Chico, Cal., an increase of 129 per cent in the number of pods resulted. Although greater seed yields also result, two experiments at least indicate that the increase in the number of seeds is not in as high proportion as is the increase in the number of pods.

Further experiments and more exact observations under varying conditions in different sections will be necessary to determine just when sufficiently increased yields of seed may be expected to justify the expense of the undertaking. Any alfalfa seed producer may test this method experimentally on a small scale.

A hundred plants may be counted off and tripped by hand three times a week during the blooming period, using either of the methods previously described. Another hundred plants of similar seeding habits should be left to be exploded by insects. Any greater production of seed on a given number of heads on the manipulated plants as compared with the same number of heads on those not so manipulated may with reasonable safety be attributed to artificial tripping.

If the increased yields which have been obtained in the preliminary experiments are equaled in seed-producing sections, it is probable that means will be devised for exploding the flowers on a large scale. The only sections in which this method will be likely to prove profitable are those where for any reason proper insects are not present in sufficient numbers to explode a large percentage of the flowers.

Areas Adapted for Seed.—The experiments thus far carried out in the production of seed in cultivated rows have been located principally in the semi-arid portions of the Great Plains, in the intermountain area, and in the Palouse country of eastern Washington. It is probable that the method will be found to be adapted to many of the semi-arid sections of the country which have a rainfall of from 14 to 20 inches, and possibly also to irrigated sections where the supply of water is insufficient for the production of full hay crops. It is also recommended for trial in irrigated sections having water for but half or less of the normal acreage of alfalfa in the district, and also for fields lying slightly higher than the ditch lines, but which have the water level moderately near the surface.

Experiments in humid sections indicate that even there row cultivation makes possible much higher yields of seed than are produced by fields sown broadcast or drilled in the ordinary manner. It is doubtful, however, whether even this method will insure the production of paying crops of alfalfa seed under humid conditions.

Row cultivation under conditions of ample rainfall is more valuable as a method of weed control than for increasing seed yields. At the time when pod formation is going on, a certain amount of dry weather and heat is necessary to insure the greatest production of alfalfa seed, even when the plants are isolated. This method promises to be more successful in sections where the annual rainfall is from 14 to 20 inches than elsewhere. Where the precipitation ranges from 20 to 25 inches thin seeding by broadcasting or drilling in the ordinary way may be preferable to row cultivation. Fields sown by either of these methods can

be kept up at much less expense. Less frequent cultivation will be necessary, and when needed may be given with an alfalfa renovator or a disk, straight-toothed, or slant-toothed harrow. Under these methods, as in row cultivation, the stand must be very thin if the best results are to be obtained.

Selection of Soil.—In the semi-arid sections the ordinary arable land, such as is used for the common farm crops, will prove well adapted to this work so far as fertility is concerned. Inasmuch as the chief purpose of cultivation is moisture conservation, soils of large moisture-holding capacity should be used when there is opportunity for choice. Care should be taken to avoid fields too alkaline for ordinary crops.

Location of Fields.—In many parts of the semi-arid sections alfalfa fields are located in swales or draws or on creek bottoms where the moisture conditions are the best that are available. Where the rainfall is very light it will be safest to utilize such places for growing alfalfa in rows for seed. Where the precipitation is greater or the run-off which the field secures from the surrounding area is sufficient, alfalfa fields, for either seed or hay, may be sown thinly either broadcast or with the drill, thus obviating a large part of the expense of cultivation. It may be safely assumed that alfalfa in cultivated rows will succeed under somewhat drier conditions than fields grown by ordinary methods. In those parts of the semi-arid sections where the rainfall is relatively heavy it is probable that even the highest and driest portions of the farm may be successfully utilized by the row method.

Preparation of the Seed Bed.—The preparation of the ground should be such as to rid it as far as possible of weeds and at the same time to provide a seed bed which has become well firmed by settling or rolling, or both. In the drier portions of the semi-arid regions summer-fallowing the preceding season may be necessary to provide the soil with the moisture required to insure prompt germination of the seed. This implies keeping the field in the cleanest possible culture during the previous summer. Weeds must be controlled and proper tillage must be given after each rain. The soil mulch thus maintained will check evaporation and in the following year place at the disposal of the young plants the greater part of two years' rainfall.

In the North, where spring planting is advisable, surface tillage must be continued until seeding time. In many cases it will not be necessary to summer-fallow if the field is devoted to a cultivated crop, such as corn, during the preceding year.

In the Great Plains country, when the ground is plowed, immediate harrowing and rolling should follow the plowing. In

addition, sub-surface packing is advised for all spring-plowed land, but may often be omitted in the case of fall plowing, as natural settling supplemented by harrowing and rolling usually produces a sufficiently firm seed bed. If firming is not done there will be at the bottom of the new furrow a dry, porous stratum of the old topsoil. This condition, which is present in all freshly plowed fields where the surface is dry, may result fatally to the young alfalfa plants, as their roots can not make the necessary development in this layer, containing dry soil, clods, and air spaces. If the field is not to be left fallow long enough for harrowing and natural settling to make the ground sufficiently firm below, this injurious condition should be remedied by subsurface packing with suitable implements. It is necessary that there be sufficient moisture in the soil at seeding time to enable the plant to make a sufficiently rapid growth to permit of surface tillage without covering up the young plants.

The purpose of subsurface packing is not to prevent loss of moisture, but to re-establish the capillary column which was interrupted by the plowing under of the dry topsoil. Unless this is done the moisture from the lower soil can not reach the roots of the plant. Immediate harrowing also prevents considerable loss of moisture from the new topsoil.

In regions where the greater part of the annual rainfall comes during the winter and where the ground does not freeze to a great depth or remain frozen for a long period, as is the case in a large part of the intermountain area and in the southern part of the Great Plains, it may be undesirable to level and firm immediately after plowing, as is indicated for the middle and northern Great Plains region. This applies only to fall-plowed land. The reason for this is obvious, as both these operations may work against the conservation of the winter precipitation by preventing penetration and promoting run-off. Rough plowed land under the conditions described holds a large portion of the moisture due to rain or melted snow and gives it an opportunity to soak in after each thaw. Spring-plowed fields in the intermountain area and southern Great Plains should be given the treatment previously indicated for similar fields in the colder portions of the Great Plains.

A promising method of securing the desired seed bed, developed by Dr. W. J. Workman, of Ashland, Kan., has been found to give satisfactory results on buffalo-grass sod. The principal difficulty in the growing of alfalfa in cultivated rows for seed is the weediness of the ground during the first season after seeding. This is avoided by the utilization of sod land. A 16-inch sod plow is

used to cut a furrow 2½ inches deep through the sod, a stirring plow following immediately in the furrow left by the breaking plow and leaving a furrow about 8 inches deep. On the next round the breaking plow puts the strip of sod in the bottom of the deep preceding furrow, where it is completely covered by the new soil turned up by the stirring plow. The harrow is kept at work to smooth and firm the ground as fast as it is turned, and the alfalfa is seeded with the grain drill while the soil is still moist.

Prevention of the Drifting of Soil.—If the ground is so sandy as to be in danger of drifting or blowing during high winds, it is the best practice to seed alternate rows of oats or barley and to make these rows run at right angles to the direction of the prevailing winds. The first cultivation of the alfalfa plants will destroy this grain nurse crop, which should in no event be left long enough to injure the young alfalfa plants.

Another method of avoiding the danger of blowing out or drifting in a sandy soil is to sow the alfalfa with a walking garden drill between corn or sorghum rows after the last cultivation. This method has been tried with success under irrigation on the experiment farm conducted by the Office of Western Agricultural Extension near Fallon, Nev. In attempting to use the method under dry-farming conditions careful attention must be given to the supply of moisture available for both plants, and as it has not yet been put into actual practice in the semi-arid sections it should first be tested on a small scale.

A third method has been suggested by Dr. H. L. Shantz, of the Office of Alkali and Drought Resistant Plant Breeding Investigations, Bureau of Plant Industry, which may prove useful when sod land is used. This method consists of leaving narrow strips of virgin sod at suitable intervals through the fields at right angles to the prevailing direction of the most destructive winds.

A method applicable especially to old fields which show a tendency to blow during high winds has been suggested by N. Schmitz, of the Office of Forage Crop Investigations, Bureau of Plant Industry. This method calls for the seeding of the alfalfa in shallow listed furrows running at right angles to the direction of the prevailing heavy winds. It is necessary that these furrows be shallow, or heavy rains which sometimes occur may bury the seedling plants. If the planting does not take place at the time of listing or if the planting attachment to the lister can not be adapted to this work, a corn drill or check-row planter may be used by making the necessary alterations in the plates. This method of listing may also prove efficient in catching the

snow during the winter preceding the planting. Spring harrowing will level the ridges if they are too high at planting time.

Choice of Seed.—Other things being equal, seed from plants grown without irrigation should be used in preference to any other. The relatively small quantity required when this method is used justifies increased precaution and expense to obtain the best seed available. Some few strains of Turkestan alfalfa have given better yields of hay than the ordinary kind under semi-arid conditions. However, none of them have shown satisfactory seed-producing capacity. Special dry-land strains of alfalfa that have been developed through unconscious selection in some of the older dry-farming centers of the West practically always exceed in seed production the Turkestan and all other forms of alfalfa thus far introduced. Whenever these kinds can be secured they should be preferred by the farmer. Seed from the drier parts of western Kansas and Nebraska, from the dry farms of Cache Valley, and from the Levan Ridge near Nephi, Utah, will probably produce the most satisfactory results.

Method of Seeding in Rows.—Several methods have been used in experiments, but the best results have been obtained by sowing seed in rows about 3 feet apart. The distance between rows should be governed by the moisture supply that can be counted on and by the width of the machinery available for use in cultivating. If seeding is done with an ordinary grain drill with shoes 8 inches apart, the stopping up of 4 out of every 5 holes will make the rows 40 inches apart. If, on the other hand, 3 out of every 4 holes are stopped up, the rows will be 32 inches apart. The wider distance is recommended, especially in sections where the rainfall is very scant.

Another method which has given good results, especially in hay growing, and which may often prove useful where it is proposed to use the same field for both hay and seed production, is that of sowing double instead of single rows. This can be accomplished by leaving 2 holes open and stopping up 3 or 4 holes across the drill. The double rows will then be 8 inches apart, while the space left for intertillage will be 32 or 40 inches wide. Experiments with this method which have been under way for two seasons on the San Antonio Experiment Farm of the Office of Western Agricultural Extension indicate that this method will be useful under some conditions. It has also been used with success under Prof. Wheeler's direction on the state substation farm at Highmore, S. D.

Any good garden drill will give satisfactory results. If such an implement is not available it may be found advisable to procure one for use in this work.

An ordinary corn drill such as is used in drilling corn in listed furrows can be used by babbitting up the holes in the corn plate and drilling new ones of proper size to drop about 15 alfalfa seeds. If a blank plate is at hand, holes may be drilled into that large enough to drop from 10 to 20 seeds. The germination value of the seed and all factors that tend to lessen the ultimate number of plants must be considered in determining how thickly to seed. The holes should be close enough to drop seeds at intervals of from 8 to 12 inches.

Lewis Brott, a pioneer dry-land alfalfa seed producer in western Nebraska, has had successful results by using an onion seed plate in a corn drill.

Rate of Seeding and Thickness of Stand.—In mature stands of alfalfa in cultivated rows the plants should average about 1 foot apart in the row. To insure this, it is necessary that the plants be much thicker at first, as their mortality under dry conditions is very high. Satisfactory results have been secured by seeding the alfalfa with an ordinary grain drill so set that it would sow 12 pounds of seed per acre with all the holes in operation. With 4 out of every 5 holes stopped up, approximately 2 2-5 pounds of seed to the acre will be sown.

The stand in a cultivated row need be no thicker even at first than that of the rows in ordinary drilled fields, though the rows of the latter are usually only about 8 inches apart. Where the conditions are not favorable, it is usually best to seed more thickly at first than is necessary and to thin out the plants subsequently to the desired stand. As much as 7 pounds of seed to the acre have been sown in 36-inch rows without producing too thick a stand for satisfactory results during the first season. This rate of seeding is equivalent to 30 pounds per acre drilled in the usual way under conditions of sufficient moisture with the rows 8 inches apart.

If difficulty is experienced in making the drill feed slowly enough, it may be overcome for the most part by mixing corn chop with the alfalfa seed or by reducing the feed in the grain drill with strips of leather.

Millet or other seed of similar size may be rendered ungerminable by heating thoroughly in an oven for several hours and then mixed with the alfalfa seed to aid in securing any desired rate of seeding. Sawdust and dry soil are also frequently used for this purpose.

It is a very good plan to test the drill first on bare soil with the shoes not touching the ground. In this way it is possible to observe the rate at which the seed is being dropped, and thus a proper regulation of the seeding can be secured. There should

be an average of from 4 to 10 plants to the running foot. It has been too often the case that the stand in the row has been too thick for the best development of the individual plants. In such instances cross-harrowing after a majority of the plants have become well established will be found to be very effective in thinning out the stand.

Seeding in Check Rows to Permit Cross-Cultivation.—Limited experiments with seeding in check rows indicate that with heavy seed-producing plants of satisfactory character very good yields of seed may be secured with hills 30 inches apart in the row. This distance permits of cross-cultivation, but is rather narrow for most cultivating machinery. The plants being thus isolated on all sides, the production of a maximum seed crop is possible. No practical means have yet been devised for seeding alfalfa in check rows on a large scale. It is probable that an ordinary check-row corn planter can be adapted to this work. It would be necessary to babbitt up the holes in the plate and then rim them out to drop 10 to 20 seeds in a place. The surviving plants can later on be thinned to the best plant in the hill. It is possible that alfalfa seeded in rows with a wheat drill could be thinned out to practically uniform distances by cross-cultivation with an ordinary corn plow run at right angles to the rows. The plants, with the exception of a few midway between the two sets of shovels, would thus be destroyed.

Time of Seeding.—Early spring seeding will usually yield the best results, as more favorable moisture conditions for the germination and growth of the young plants are present at this time. However, if the soil can be brought into proper condition of tilth and moisture content, seeding can take place during the late summer if the danger of winterkilling is not too great. In a climate of moderate severity if a 6-inch growth is made during the fall the plants will probably go through the winter safely, and will start out the following spring in much better condition to compete with the weeds than will spring-seeded plants. In semi-arid regions it is usually impracticable, however, to seed alfalfa in late summer or early fall owing to the lack of moisture necessary to insure prompt germination.

In the Dakotas and Montana, June seeding will probably give the best results. If seeding is deferred until early summer and the soil is harrowed or otherwise treated to keep it in proper tilth, most of the weed seeds near the surface will germinate. The last cultivation given the land before the alfalfa is sown kills this young growth, thus greatly reducing the trouble with weeds during the first season.

Treatment of the Stand the First Season.—The well-settled

moist seed bed necessary for the growth of alfalfa furnishes ideal conditions for the rapid development of weeds. Several cultivations are necessary to hold even those of the first season in check. A 2-row cultivator provided with narrow shovels is the most practicable machine for this work. Fenders, or, better, a box sled, should be provided to avoid the danger of covering up the young alfalfa plants, and care should be taken to ridge up the rows as little as possible, as this will interfere with mowing operations. After the stand has become firmly established ridging can be readily corrected by cross-harrowing. Mr. Bartholomew has devised a harrow of adjustable width which is very useful both in controlling weeds and keeping up the necessary surface mulch.

The stand may be much thicker during the first season than in subsequent seasons. Some of the plants will be destroyed by cultivation, and the less drought resistant and less hardy plants will be killed by the dryness of the summer and the cold of the first winter. Unless plants are so thick as to crowd one another no thinning should be done by cross-harrowing while the plants are still small.

Experiments in eastern Colorado, eastern Washington and California indicate that under very dry conditions the plants should not be clipped the first season if they are to make their greatest individual development. On the other hand, in the Willamette Valley of Oregon it has been found necessary to clip during the first season. In any event, clipping, if undertaken at all, should be with the sickle bar of the mower set high, and probably should not be resorted to unless it is found impossible to hold the weeds in check by the ordinary cultivations. As there is still some uncertainty regarding clipping the first season, it is suggested that farmers leave a portion of the field unclipped to demonstrate the best practice under various conditions. Should the plants begin to set seed, clipping will be advisable. In cases where it is practicable, hand weeding or hoeing may be used to supplement horse cultivation.

Treatment of the Stand After the First Season.—The treatment of the stand during subsequent seasons will differ very little from that of the first season. The plants should average not more than four to the foot. In the spring or early summer of the second season, if the natural methods of thinning out have not been severe enough, it will be necessary to harrow crosswise lightly to accomplish a further reduction in thickness of stand. It may also be worth while to go over the rows with a hoe as soon as the plants commence to set seed, cutting out undesirable individuals. This operation will involve considerable time and

expense. However, as there is such great variation in the value of different plants, this procedure may be justified at least until strains of known high value for the conditions at hand have been selected and propagated for use on a field scale.

Row-sown alfalfa fields that have not been properly thinned will not give maximum seed yields on account of the various injurious effects of crowding, which have already been discussed.

If it is impracticable to reduce the stand by hoeing or by use of the ordinary harrow it may be done by cross-disking with a disk harrow. The disks should be so adjusted as to cut out the proper number of plants, which will depend, of course, upon their original thickness in the rows.

The Right Crop to Leave for Seed.—Experiments at Stockton, Kan., show clearly that at that place no crop later than the second will yield returns that will be at all satisfactory. Retarded growth during the dry part of the summer defers ripening until so late in the season that cold nights prevent the maturing of the seed. On the other hand, if the first spring growth is devoted to seed production the flowers are likely to become overmature before the best season for seed development arrives. Frequently also, largely on account of the variation in location of the zero point of growth in the different individuals composing any strain, the first spring growth matures very unevenly.

For these reasons it is recommended, especially for the Great Plains and the cooler parts of the intermountain area, that the first growth of the second and subsequent years be clipped so early that the time of seed setting will fall in midsummer or slightly later, when favorable conditions are likely to obtain.

The problem as to what crop should be left for seed under the varying conditions of different areas has not yet been fully worked out. It may be well for seed growers to try by simple experiments along this line to get definite information on this point. One row may be given an early clipping and then left to go to seed; another a later clipping, while still another may be left for seed after the first crop has been cut for hay, and so on. The temperature and moisture requirements will largely determine the best practice in this regard, but the necessary presence of suitable insects must not be overlooked.

Harvesting the Seed Crop.—The harvesting of alfalfa seed grown in cultivated rows does not differ materially from that in broadcasted fields. With the rows 3 feet apart a mowing machine with a 6-foot cutter bar is necessary if two rows are to be cut in each swath. This arrangement does away with the necessity of having an extra man to remove the newly cut bunches from the path of the mower at the next round. A mower with a

5-foot cut has been found to be too short to be satisfactory in cutting two rows at once.

It is probable that a center-cut mower with one horse attached at each end of the cutter bar will prove better adapted than even the 6-foot side-draft machine.

In planning to sow alfalfa for seed in cultivated rows the farmer should make his plans from the very beginning with a view to using to the best advantage the available machinery. In adapting the grain drill to secure the proper distance between rows, the mower with which the cutting is to be done must be kept in mind, as well as the cultivators that are to be used in controlling the weeds and keeping up the dust mulch.

Thrashing may be done either from the field or from the stack. The latter method is probably the better, as curing in the stack seems to improve the quality of the seed. The haste necessary in order to keep the machines busy when thrashing is done from the field results in considerable waste. Whichever method is employed in handling the seed crop, it is necessary that a tight-bottomed rack be used or there will be much loss of seed. Such a bottom can be secured by the use of matched flooring or by spreading canvas or a tarpaulin over the bottom of an ordinary open rack.

Thrashing may be done in any one of three ways—the regular alfalfa huller, an ordinary grain separator supplied with a hulling attachment, or a grain separator fitted out with alfalfa sieves may be used. The last has been found to give very satisfactory results. Failure to appreciate the fact that the ordinary thrashing machine can be adapted to the thrashing of alfalfa has resulted in the loss of the seed crop on many fields in sections where seed production is not often attempted or, if attempted, is successful only in abnormal years or where it is carried on incidentally to other farming industries. In using the ordinary thrasher it is recommended that the concaves be inverted in addition to inserting the special clover or alfalfa sieves.

Possibilities of Seed Production in Cultivated Rows.—Too much must not be expected from the method of growing alfalfa described in these pages. There are large areas in and around the regions to which this method is adapted where no amount of cultivation and isolation of the plants will bring success. On the other hand, there are thousands of acres now lying idle which with intelligent management will yield profitable crops. Maximum or bumper crops must not be expected under the prevailing conditions.

The results obtained in the experiments thus far conducted with this method indicate that it gives especial promise in Utah, in

eastern Colorado, and in the western portions of Kansas, Nebraska and South Dakota. Yields of seed at the rate of 5 bushels to the acre have been obtained. The possibilities of the method when only individual plants of large seeding capacity are used is indicated by the fact that plants removed 30 inches each way from other plants have given yields which if equalled by an acre of such plants at the same distance apart would rival the seed yield produced under the most favorable conditions in the present seed-growing sections.

The method is a comparatively new one and should be tested on its own merits in each area or even in each community. Where reasonable doubt as to its success under given conditions of rainfall exists, growers should at first devote only a small area, say 2 to 5 acres, to row cultivation, increasing the size of the field if the results justify it.

Seed production under the best conditions is somewhat uncertain. The certainty of profitable yields of hay in most alfalfa-growing sections deters many farmers from letting their fields stand for seed. The light yield of hay procurable under ordinary conditions in the semi-arid regions makes the growing of seed a more promising undertaking than in sections where hay production is very profitable. It is probable that under very dry conditions the yield of hay in cultivated rows will also exceed that of a broad-casted stand. Complete data are not yet at hand, but calculated yields per acre based on the weight from a typical rod length of row are given in the accompanying table:

VARIETY.	Green weight of hay.	Dry weight of hay.	Weight of seed.
Dry-land alfalfa (Brott's)	2,672 lbs.	1,154 lbs.	167 lbs.
Commercial sand lucern (S. P. I. No. 20451)	3,463 lbs.	1,359 lbs.	143 lbs.
Turkestan alfalfa (S. P. I. No. 18751)	2,141 lbs.	908 lbs.	62 lbs.

The yields of hay given in this table are from one cutting obtained on an upland field near Potter, Neb., sixteen months after seeding. The mean annual rainfall at Kimball, the nearest point for which precipitation records are available, is about 14 inches. In both 1905 and 1906 this mean was exceeded considerably, but in 1907 the total was 15 inches, while up to the end of September, 1908, the record showed 13.85 inches. Lewis Brott, on whose farm this experiment is under way, secured 150 bushels of seed from a thinly sown, broad-casted field of 50 acres in 1906. This yield was obtained from an old stand.

Developing Valuable Strains for Seed Production.—Experiments

under way at the Arlington Experimental Farm, near Washington, D. C., at Pullman, in the eastern part of the state of Washington, and elsewhere tend to prove that heavy-seeding propensity is heritable to a marked degree. In consequence of this, a race of unusual excellence could readily be secured by propagation of the progeny of individuals selected on this basis.

When alfalfa is grown in rows to permit of intertillage, it is much easier to make selections than in broad-casted stands, chiefly because individuals in rows have better opportunity for expression of their normal character. In addition, the comparative isolation of the plants gives readier access to them.

At first thought it might appear that in thinning out stands of row-cultivated alfalfa, only individuals of the greatest seed-producing capacity should be left. A second thought quickly reveals the fallacy of this idea, as the ultimate purpose of all alfalfa growing is hay production. Selection based on seeding habits alone will develop this side of the plant unduly at the expense of its forage-producing capacity. The highest type of alfalfa for use in areas where seed production is the primary purpose in growing the crop is one that combines satisfactory hay and seed producing quality in symmetrical proportions.

It is recommended that the selection of desirable plants commence as soon as the preliminary seeding has developed plants large enough to show their value. The field should be inspected row by row, and seed of the selected plants should be gathered in advance of the regular harvest. The relatively small quantity of seed secured in this way should be sown with great care to make it cover the greatest possible area of ground. The plat of alfalfa thus secured will produce seed of much greater value than that obtained from unselected plants. If this method is carried out, materially increased crops of seed may be secured without detracting from the hay value of the strain. Indeed, both the hay and the seed producing capacity may be increased by the process.

If it is impracticable to secure sufficient seed from selected plants for all of the new seedings that one desires to make, the selected seed should be planted separately, and that harvested from this plat should be used for subsequent seeding. This method will also afford an opportunity for demonstrating the relative value of selected as compared with unselected seed.

Conclusion.—The results obtained by farmers on a field scale, as well as of the experiments thus far conducted, indicate that the growing of alfalfa in cultivated rows for seed in the semi-arid regions offers every promise of success. The method is recommended particularly for those sections where on account of the

light rainfall but one crop, or at best two crops, of alfalfa hay can be secured in each season.

Next to the problem of providing and maintaining a firm, moist seed bed, the controlling of the weeds offers the greatest difficulty. This is especially true during the first season, when their rapid growth makes it difficult to control them by cultivation owing to the danger of covering the small alfalfa plants.

It is expected that the machinery now in use in most communities can be adapted to the growing of seed in rows. While the results indicate that the row method of culture will probably become an efficient factor in the development of the semi-arid regions, too much must not be expected of it. Those undertaking the work will be pioneers. To them will fall the task of developing new devices and special adaptations of the implements at hand, upon which will depend in large measure the practical success of the method.

The alfalfa plant requires but a small supply of moisture when seed setting is going on. Heavy seed crops are to a large extent dependent upon the prevalence during this time of a certain amount of dry weather and heat. In many parts of the semi-arid regions an unusually favorable combination of these conditions is present. The power to regulate by surface tillage the supply of soil moisture makes the method of growing alfalfa in cultivated rows for seed of especial promise in those parts of the Great Plains, intermountain area, and other sections where the average annual rainfall ranges from 14 to 20 inches.

Alfalfa in Dry Farming.—P. K. Blinn, of the Colorado agricultural college, thus tersely advises those attempting dry farming:

If a farmer on the dry plains has a well that will furnish just enough water for fifty head of stock, it would be absurd for him to try to keep sixty or seventy head on the same supply of water; and it is equally ridiculous for him to attempt to crowd plants in soil where the moisture is limited.

Some plants may develop with less moisture than others, but alfalfa is not one of these plants; on the other hand, it is conceded by all western farmers than an abundance of moisture is the key to success in growing alfalfa for hay. When it is well established, alfalfa will endure long droughts and still revive when water is applied; to that extent it is adapted to dry farming, and its deep-rooting tendency may enable the crop to grow without irrigation, if the roots can penetrate to moist soil. There are many localities on the plains where the run-off from heavy show-

ers could be collected and diverted by ditches upon soil suited to alfalfa. Often in a draw, where moisture from the surrounding prairie is inclined to center, good encouragement for seeding to alfalfa is offered.

The number of plants to the acre that can be maintained in the dry farming district has not been determined; but at Rocky Ford, Col., in 1908, an alfalfa nursery plant, without irrigation for eleven previous months, produced at the rate of two and three-fifths tons per acre the first cutting; and then made a second cutting equally as good, that was left for seed. The plat had been seeded in 1907 to Turkestan alfalfa, and thinned to single plants twenty inches apart each way. It received one irrigation and was thoroughly cultivated that year. The growth in 1908 was made on the moisture that was stored and conserved in the soil, but such phenomenal yields can hardly be expected without irrigation. In the favored spots, before mentioned, alfalfa can certainly be grown if once established and properly managed.

The growing of alfalfa seed offers great opportunities to the farmer on dry lands, because the fact has been well demonstrated that alfalfa yields seed best when the plant makes a slow, dwarfed growth, when it really lacks for moisture, but has enough to set and fill the seed. Seed grown under dry conditions has more vigor and vitality than seed produced with an excess of moisture, and it is usually free from dodder and other noxious weeds, if the field has had any cultural care. There is a demand for dry land alfalfa seed that far exceeds the supply.

In establishing alfalfa for seed production, under dry conditions, it is recommended to sow in rows eighteen or twenty inches apart, with two to three pounds of good seed per acre. A thin, uniform stand is absolutely necessary, even to thinning, as in beet culture; but the stand can usually be regulated by the amount of seed sown. It has been found that plants twenty inches apart will support each other and not lodge or lay on the ground, as in thicker or thinner stands. With a good stooling variety like the Turkestan, plants six to twelve inches apart in the row are thick enough. If all the seed would germinate, one pound per acre would be ample, but it is difficult to sow a small quantity uniformly in the row, and for seed production it might pay to space and thin the plants.

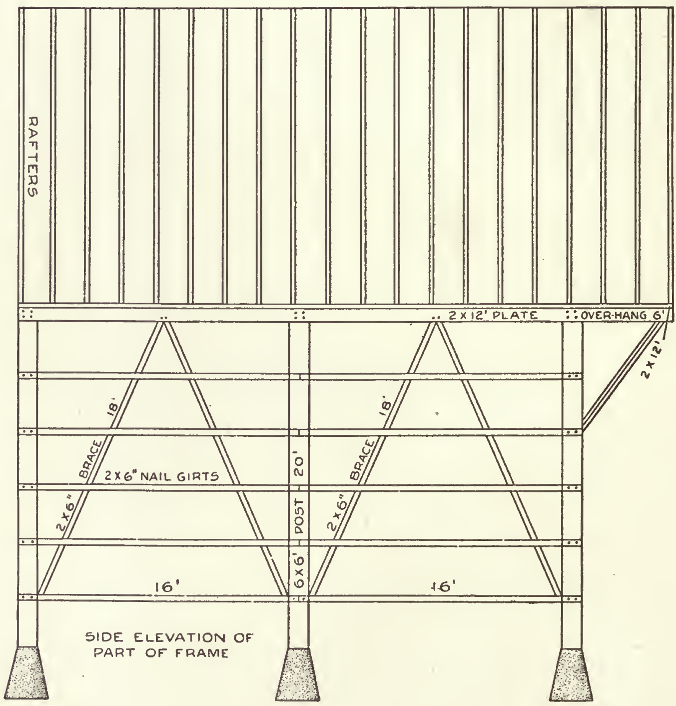
The row system is essential, as it permits intertillage to eradicate weeds, and to conserve the moisture, and also allows deep cultivation to absorb winter storms, affording an opportunity to furrow out the rows and to direct or divert any surface water that may or may not be needed. It is the only system that will allow the tillage that is so essential to all dry farming.

The four-row beet cultivator, with its weeding knives and other attachments, is an ideal tool for cultivating the crop. A four-row drill adapted to sowing alfalfa seed is needed to complete the equipment, but the ordinary beet drill, with the addition of an alfalfa or grass seeder attachment, can be modified to suit the work. The seed should be sown shallow, not over an inch deep, and good results have been secured with the common garden drill by marking out the ground with the rows gauged in sets of four, to correspond to the four-row cultivator.

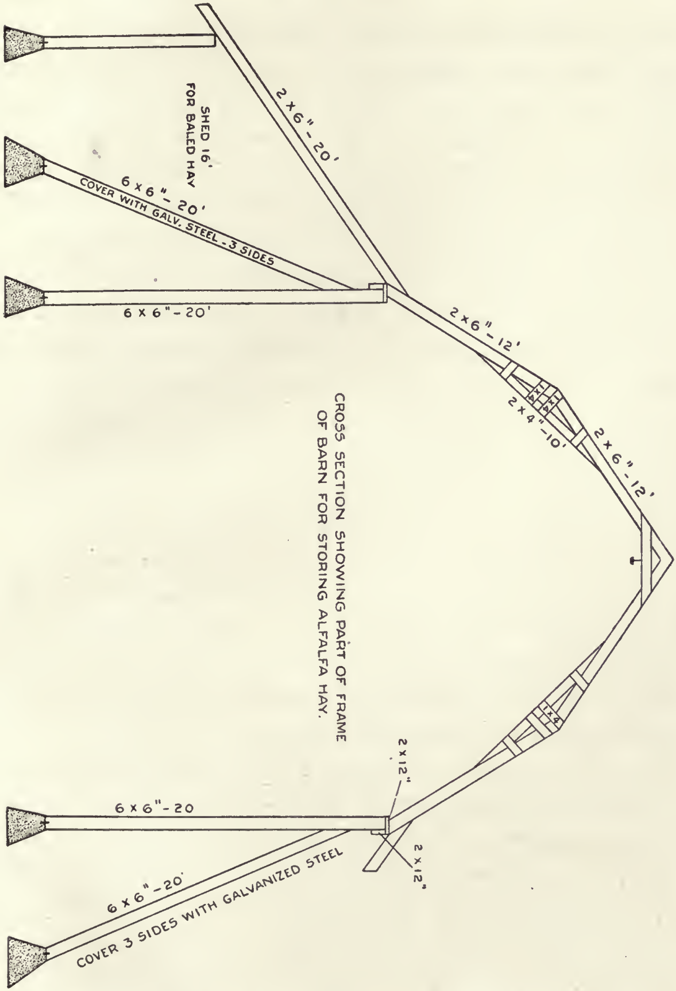
Where there is an opportunity to use irrigation or flood water, the field should be ditched in every other row, and the furrows "logged out" with a sled made of short logs, 8 to 10 inches in diameter, and from 3 to 4 feet long, spaced to fit two furrows, so that the water may be run through as quickly as possible, for the alfalfa crop for seed will need as little water as can be applied. A short rush of water after a sudden shower can be delivered over considerable ground if the field is properly ditched.

BARNS AND SHEDS FOR STORING HAY.

Alfalfa hay east of the Missouri River ought always to be put under cover. In very truth it ought to be put under cover in any climate humid enough



to grow the crop without irrigation. When one builds a barn or shed for storing alfalfa he should consider a few basal truths.



Desirable Conditions.—It is essential that the mow have depth. It is costly to roof a shallow mow. The mow should have no cross ties. Alfalfa is much

easier put in with modern sling carriers if there are no cross ties to obstruct the working of the carrier. The roof must be strong if hay is taken in in large drafts. It must be of economical construction. It must be able to endure stress of wind and storm.

The writer has designed hundreds of barns of varying types for situations scattered nearly all over America. After many years of experience he decides that for simple storage of hay the type shown on pages 466 and 467 is the best extant. It is as simple as can be, it is cheap to build. It may have round pole for posts, square timbers or be all of joists construction. It has not one brace or cross tie inside the hay mow. The outer braces are not in the way especially, as they occur only at intervals of 14′ or 16′. They will not decay if they are covered on top and sides with a strip of galvanized steel roofing, bent to fit. The under side is best left uncovered. The foundation is of concrete piers molded in place and each one having an iron pin coming up several inches into the foot of the post.

A floor ought to be provided. Sometimes a scaffolding of round poles is laid down, putting the poles close enough to make a good air space under the hay. A concrete floor made water proof will serve if care is taken to put down very dry straw or hay at the beginning so as to make a layer all over the bottom.

Shed for Baling.—Supposing hay to be baled from this barn, a shed or lean-to is provided on one side. Each crop may be baled as soon as it has thorough-

ly gone through its sweat and the baled hay piled in the shed, the bales on edge, as much air space between them as possible. A good wooden floor should raise the bales well above ground moisture.

Siding.—This hay barn may be sided clear down or only part way. It is best to side clear down, since driving rains will damage the hay enough to make siding profitable. The nail girts are 2′x6′, spiked in place, and the siding put on vertically. The roof is best perhaps of galvanized steel, or else of good shingles, though there are good ready-made roofings of asphaltum base.

Frame.—Another illustration shows quite clearly the side of the frame with posts set 16′ apart. The long braces support the plate so that it is as though posts were set only 8′ apart. The box plate on which rafters rest should be strongly made. Use two pieces of 2x12″ stuff and the roof will keep in perfect shape.

Driveway.—Hay may be taken up from a transverse driveway or from the end. If from the end it ought to face the East, or preferably the Southeast. The construction of the overhang is indicated in the drawing. Brace it strongly. If an overhang is provided one can have also a transverse driveway and from it fill the barn till all is full except this driveway, which can then be filled from outside. An overhang of 6′ width, the sheeting and roof extending out 24″ farther, will protect a load of hay if the barn is turned away from the direction of storms.

ALFALFA IN TEXAS.

The overshadowing importance of Texas in its new agricultural development renders information concerning alfalfa growing in that vast commonwealth of unusual interest. A summary of the situation is thus presented through the kindness of Prof. H. H. Harrington, Director of the Texas Experiment Station at College Station:

The oldest alfalfa fields in Texas are in the Rio Grande valley below El Paso, around Ysleta. Some fields there have been continuously in alfalfa for 25 years, and with reseeding the ground has been in alfalfa for 40 years.

The best area in Texas adapted to alfalfa growing would be very difficult to specify in explicit fashion. There are so many areas being developed to this plant, and the industry is comparatively so new, that I could not say definitely as to the superiority of any particular section. I am inclined to think, however, that without irrigation the Red River valley in the Panhandle is the most desirable locality. Much of the Panhandle proper, especially along the draws and in the valleys, is admirably adapted to growing alfalfa. The black lands of North Texas, from Dallas north particularly, seem well suited to the growth of alfalfa on land that is not affected by the cotton root rot.

The largest development of alfalfa growing at the present time is in the Pecos Valley, in Ward County, at Barstow, and at Grand Falls, in Pecos County, and in the Toyah valley, in Reeves County.

The question as to what part of the state would be foremost in seed production is susceptible of considerable conjecture. However, it will probably be the Panhandle from Chillicothe north.

As to the growth of alfalfa in Mexico across from Del Rio, I cannot say. The Lower Rio Grande soils, however, are growing alfalfa successfully at the present time, but the industry has not been established long enough to determine whether or not it can be carried on for a number of years successfully. They are likely to meet with some soils that will kill out the alfalfa from cotton root rot, just as the soil of Don Trevino failed.

I have no data as to the definite relation between the lime con-

tent of soils and the growth of alfalfa. I am satisfied, however, that under other favorable conditions only a very small percentage of lime is necessary—say three per cent of the carbonate. In Hays County and in Comal the amount of carbonate of lime in the soil is very high, some analyses which we have showing as much as 25 per cent. In the Pecos valley the percentage of sulphate of lime, or gypsum, is very high, and such soil is admirably adapted to the growth of alfalfa, but that soil, unfortunately, contains a considerable quantity of alkali, mainly the chloride of soda or common salt, and a little carbonate of soda; but after one or two years' use with a sufficiency of water these soluble salts seem to be washed out, and then the soils remain as perhaps the best alfalfa soils in the state. I understand that these same conditions prevail around Roswell, New Mex.

I would advise sowing in the fall as the best method of establishing alfalfa fields in Texas. This, in the northern part of the state—say from the Texas & Pacific railroad north—may be done as early as August, and preferably not later than September; while in the southern part of the state sowing may take place as late as December. The thing to be sought is to get the alfalfa well started with a good growth before the freezing weather of winter. Of course, every one now knows that in what is known as the rain belt proper, the main difficulties with alfalfa during its first year are weeds and crab grass, so far as conditions in this state are concerned. It is therefore well if possible to have one year's clean cultivation of the land prior to putting it in alfalfa, and I regard it as essential that especially the summer immediately preceding the seeding of the land to alfalfa in the fall must have been one of clean cultivation. The land also for a month before the time of seeding should have been well plowed, not necessarily deep, in the rain belt, but the surface preparation should be of the best. The disk harrow is the best implement for this purpose, and then keep the surface well stirred with an Acme harrow or with a weeder, in order that when a rain comes, seeding may take place soon thereafter. When the ground is caught in just the right condition, the seed may be sown broadcast or in drills, preferably the latter, although it is a little more trouble. A light roller over the land will then secure a better stand.

In the spring if weeds and grass appear, it may be necessary to mow the alfalfa when it is five or six inches high, merely to kill the weeds and the grass. If the first summer happens to be a dry one the crop, after having yielded one to three cuttings, may fail and reseeding the following fall be necessary. This will not usually be the case, but it sometimes happens. The farmer however should not be necessarily discouraged. He may either

harrow and reseed the spots that are most bare, or plow up the entire field and reseed it. After the first year if the alfalfa has done well it ought to be disked with a harrow, preferably after each cutting; certainly twice a year, setting the disk so as to cut about four inches, and lapping on the return round. Some practice disking both ways, after which a smoothing harrow or a roller is passed over the field to smooth it. An alfalfa renovator may be used instead of the harrow. Even on irrigated land some cultivation is desired.

I do not attach very much importance in this state at least, to the inoculation of the soil. I have never known a crop of alfalfa to fail here from neglect of this precaution. Most of our soils seem to be either naturally inoculated, or to become so very soon after the growth of alfalfa is begun.

The number of cuttings varies from three to seven. I recently saw a 60-acre field cut the third time that produced at that cutting eighty tons of the prettiest alfalfa that I ever looked at. This was in the Toyah Valley. Their practice in haying is to windrow the alfalfa the second day after cutting, and then with buck rakes bale from the windrow in the field, being careful to throw aside any swaths that seem a little too green. I do not mean green as to color, but as to sap. Such alfalfa has all the leaves preserved and is as green and as fresh-looking in the bale as it is in the field.

Of course this is quite a dry climate. In the rain belt I would advise cutting in the morning after the dew is off and windrowing next morning after the dew is off, and if it is to be stacked, it may be put up that afternoon. If it is to be baled, it should be given a little more time in the stack or shock, but this is not always necessary. One season's experience is almost essential for successful alfalfa growing, and the intelligent farmer will soon learn to recognize and correct the difficulties of his particular locality.

ALFALFA IN HAWAII.

Interesting information as to alfalfa on one of our island possessions in the western seas comes thus from E. V. Wilcox, special agent in charge of the Hawaiian Experiment Station of the Department of Agriculture at Honolulu:

This station has not published any bulletins on the cultivation of alfalfa, but the matter has received considerable of our attention, and the crop is successfully grown in a number of localities. It may be interesting to learn that during last season a fairly good stand of alfalfa was obtained on the Parker Ranch, at an altitude of 4,700 feet, with a total annual rainfall of only two inches. The crop stood about 30 inches high when I last saw it in December.

Where alfalfa stubble is promptly irrigated after each cutting, twelve crops per year are obtained, and in exceptional cases thirteen. On a large dairy farm near Honolulu, alfalfa reaches the blooming stage and is cut every thirty days the year round. A crop has been made in 26 days. Thus far little attention has been given to the making of alfalfa hay, since alfalfa may be obtained green the year round.

The greatest difficulty experienced in our islands in growing alfalfa is that furnished by cutworms. These pests eat off the young plants when about two or three inches high. It has been found best to plant new land to sorghum for a year or two, after which the cutworm attacks are not serious enough to interfere with the growth of alfalfa.

In most localities in Hawaii alfalfa does not reach the height which it attains in the Rocky Mountain region or in the eastern states, but the stems are perhaps less woody, due to their rapid growth, and are abundantly furnished with leaves almost to the ground. The quality of the forage is therefore very good. Alfalfa is raised here chiefly for soiling dairy cows, but is also fed to pigs, horses and other stock. I have never known of a case of bloating caused by the feeding on green alfalfa or from pasturing on the young crop. It is not quite certain why we are free from this trouble.

The area devoted to alfalfa is being continually increased. On the Parker Ranch one ton of seed was planted this spring and various other ranches are increasing their areas as fast as they are able to overcome the difficulties of getting the crop started.

ALFALFA IN ALGERIA.

In France and Algeria, according to Bulletin 33 of Gouvernement General De L'Algeria, deep plowing for alfalfa is urged. The soil should be stirred to a depth of at least 20 inches. There alfalfa is sometimes drilled in rows 16″ apart. The rate of seeding advised for Algeria is about 16 lbs. per acre when sown broadcast or 12 lbs. when sown in drills. Mention is made of a field where the yields of ''fourraige frais'' or green fodder, in three or four cuttings in successive years made 8, 16, 22 and finally 32 tons per acre. In that land they have learned the need of lime and recommend large amounts, also of phosphorus and advise the use of 1,000 lbs. per hectare or about 400 lbs. per acre of superphosphate.

Mention is made also of the fact that there is a native race of alfalfa in the oases of the Sahara desert and that alfalfa from southwestern America thrives in Algeria better than seed from France.

This bulletin states the peculiar fact that alfalfa thrives in Algeria in small fields, well enriched, well plowed, well cared for, but that it is not usually very successful in large fields.

VITALITY OF SEED.

The United States Experiment Station Record, Vol. VI, No. 5, gives in a tabular form the result of an eleven years' test of the duration of the vitality of some agricultural seeds made by S. Samck, from which the following is taken. Well matured seed was selected, a portion of which was examined each year from 1883 to 1894. The unused portions were kept in paper bags in a dry airy room and seeds taken from them each succeeding year for the test.

KINDS OF SEED.	PERCENTAGE OF VITALITY.										
	1 year.	2 yrs.	3 yrs.	4 yrs.	5 yrs.	6 yrs.	7 yrs.	8 yrs.	9 yrs.	10 yrs.	11 yrs.
Alfalfa	94	91	87	75	72	71	68	66	63	59	54
Red Clover	90	90	88	84	74	68	44	16	10	3	2
Alsike	73	64	51	37	15	7	6	5	3	3	3
White Clover	74	72	63	52	50	50	35	31	26	23	22
Timothy	95	93	90	88	86	79	66	39	15	1	0
Orchard grass	46	47	41	44	38	29	21	12	8	5	..

It will be seen that in the first year of the experiment, out of 100 seeds of alfalfa planted, 94 germinated; of the same number of red clover, 90 germinated; of alsike, 73; of white clover, 74; of timothy, 95; of orchard grass, 46; while in the eleventh year but 54 out of the 100 seeds of alfalfa grew, 2 of red clover, 3 of alsike, 22 of white clover, and none of either timothy or orchard grass. According to these figures, age does not affect the vitality of alfalfa seed so much as it does the other seeds used in the experiment. No observations, however, were made by the experimenter regarding the strength of the plants from the old seed as compared with those from the new seed.

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